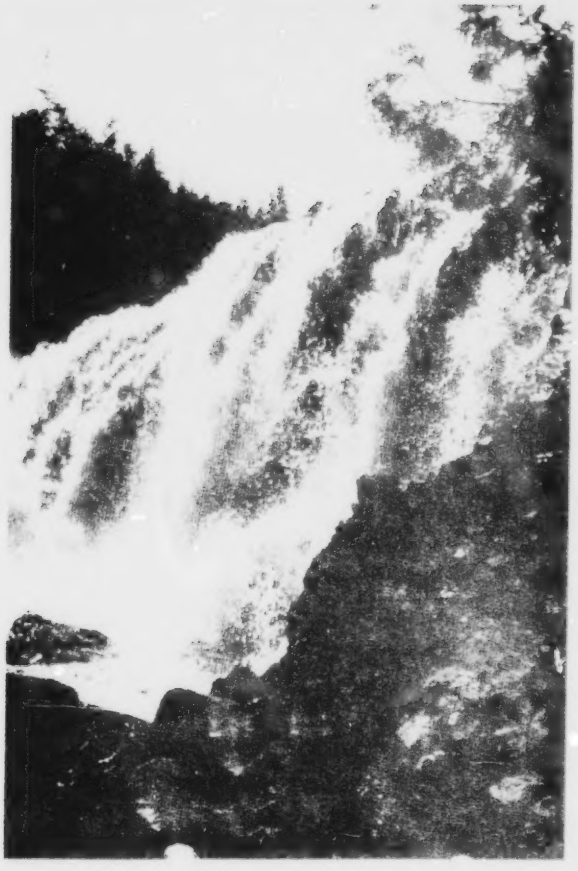
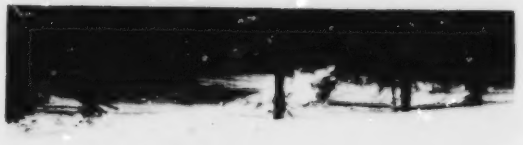
Pukaskwa National Park





Natural Resource Conservation

Environment Canada

Parks Service

91-03717/

AQUATIC RESOURCES INVENTORY FOR HATTIE COVE PUKASKWA NATIONAL PARK

By
Doris Odjick
Park Warden

October, 1990
Canadian Parks Service
Environment Canada

ABSTRACT

The purpose of this study was to obtain baseline data for the aquatic resources in Hattie Cove in order to establish the need for fishing regulations for pike (Esox lucius). The methodology was carried out according to A Study Design For: Aquatic Resources Inventory, Hattie Cove, Pukaskwa National Park (Moreland 1988).

The results indicated that Hattie Cove contained a low population of benthic fauna, and minnows; and that pike were assumed to migrate to and from the cove and not permanent residents as once believed. The aquatic resources inventory will provide baseline data for future monitoring, and planning in fisheries management.

The study revealed that Hattie Cove does provide pike with valuable spawning habitat, however, the results indicated low populations of benthic fauna and minnows. It was assumed that pike were not permanent residents of Hattie Cove as demonstrated from the telemetry study. Also, the fish tagging efforts could not calculate a population. If future studies are needed, this report contains the baseline data for comparisons.

Key words: benthos, ultrasonic telemetry, creel census

Citation: Odjick, Doris. 1990. Aaquatic resources inventory for Hattie Cove, Pukaskwa National Park. Unpublished report, Canadian Parks Service, Pukaskwa National Park, Heron Bay, Ontario. 64p.

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The collection of data could not have been accomplished without the assistance of the wardens, and student workers at Pukaskwa National Park.

LIMITED DISTRIBUTION LIST

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TABLE OF CONTENTS

ABSTRACT.....ii

ACKNOWLEDGEMENTS.....iii

TABLE OF CONTENTS.....v

LIST OF TABLES.....vii

LIST OF FIGURES.....viii

LIST OF PHOTOGRAPHS.....ix

LIST OF MAPS.....x

1.0 INTRODUCTION.....1

2.0 BACKGROUND INFORMATION REVIEW.....1

3.0 METHODOLOGY.....2
- 3.1 General Inventory - Map Work.....2
- 3.2 Water Quality.....6
- 3.3 Benthic Fauna.....8
- 3.4 Minnow Trapping.....13
- 3.5 Fish Tagging.....13
- 3.6 Ultrasonic Telemetry.....16
  - 3.6.1 Surgical Implantation.....16
  - 3.6.2 Tracking.....17
- 3.7 Creel Census.....17
- 3.8 Mercury Analysis.....21

4.0 RESULTS.....21
- 4.1 General Inventory - Map Work.....21
- 4.2 Water Quality.....29
- 4.3 Benthic Fauna.....34
- 4.4 Minnow Trapping.....34
- 4.5 Fish Tagging.....37
- 4.6 Ultrasonic Telemetry.....42
  - 4.6.1 Success of Surgical Procedure....42
  - 4.6.2 Tracking Results.....44
- 4.7 Creel Census.....48
- 4.8 Mercury Analysis.....48

5.0 DISCUSSION.....48
5.1 General Inventory - Maps.....48
5.2 Water Quality.....48
5.3 Benthic Fauna.....52
5.4 Minnow Trapping.....53
5.5 Fish Tagging.....53
5.6 Ultrasonic Telemetry.....53
5.6.1 Surgical Implantation.....53
5.6.2 Tracking.....54
5.7 Creel Census.....55
5.8 Mercury Analysis.....56

6.0 CONCLUSION.....56

7.0 RECOMMENDATIONS.....57

REFERENCES CITED.....59

APPENDICES

A Field and Lab Summary
Terms of Reference for Benthos Sample Identification
Benthos Sample Identification for Hattie Cove, Pukaskwa National Park, 1989

B Field Tally Sheets

C Creel Census Arithmetic Formulae

D Volume and Mean Depth Calculation for Hattie Cove

E Statistical Formulae for Creel Census

LIST OF TABLES

TABLE 1 Depth of Water and Ice at Sediment Sample Sites

TABLE 2 Description of Sweep and Ekman Sample Sites

TABLE 3 List of Aquatic Plant Species for Hattie Cove

TABLE 4 Water Quality Analysis Results

TABLE 5 Benthos Sample Summary

TABLE 6 Minnow Trap Sets Summary

TABLE 7 Fish Tagging Hattie Cove 1988

TABLE 8 Fish Tagging - Telemetry, Hattie Cove 1989

TABLE 9 Status of Fish Survival after Surgical Implantation of Transmitters

TABLE 10 Summary of The Movement of Pike in Hattie Cove

TABLE 11 1989 Creel Census Summary

TABLE 12 Hattie Cove Tissue Samples - Mercury Results

LIST OF FIGURES

FIGURE 1 Traversing Transect Lines for Bathymetric Map

FIGURE 2 Water Quality Testing Sites

FIGURE 3 Sediment Sample Sites

FIGURE 4 Sweep and Ekman Sample Sites

FIGURE 5 Minnow Trap Sites

FIGURE 6 Lake Trap Net

FIGURE 7 Trap Net - Hoop Style

FIGURE 8 1974 Field Map

FIGURE 9 1989 Field Map

FIGURE 10 Land Type Legend

FIGURE 11 Success Location Site for Capturing Pike

LIST OF PHOTOGRAPHS

PHOTOGRAPH 1 Water Level Bench Mark

PHOTOGRAPH 2 Location of Water Level Bench Mark

PHOTOGRAPH 3 Measurement of Pike

PHOTOGRAPH 4 Surgical Incision

PHOTOGRAPH 5 Transmitter Insertion

PHOTOGRAPH 6 Transmitter Insertion

PHOTOGRAPH 7 Suturing the Incision

PHOTOGRAPH 8 Release of Surgically Implanted Pike

LIST OF MAPS

Hattie Cove Base Map

Hattie Cove Bathymetric Map

Hattie Cove Land Type Map

Hattie Cove Shoreline Soil Type and Terrestrial Vegetation Map

Hattie Cove Aquatic Vegetation Map

1.0 INTRODUCTION

Hattie Cove is a body of water of Lake Superior within Pukaskwa National Park. It is located adjacent to a developed 67 site campground, day use area, and visitor centre. With road access to its back-shore, Hattie Cove is subject to fishing pressure during both summer and winter seasons. It is also one of the few locations in the park where northern pike (Esox lucius) grow to a relatively large size.

The Sport Fish Management Plan Pukaskwa National Park (Schiefer et. al. 1986) outlines the need for basic aquatic resources inventory of all lakes/bodies of water within the Park which have active sport fishing, and those waters which contain a unique fish population. Hattie Cove was designated as a prime consideration.

The purpose of this study was to inventory the aquatic resources according to the methodology set out (Moreland 1988). An ultrasonic transmitter study was also initiated to determine if the pike were permanent residents of Hattie Cove.

2.0 BACKGROUND INFORMATION REVIEW

The Sport Fish Management Plan (Schiefer et. al. 1986) stated the need to carry out basic aquatic resource inventory of Park waters which support sport fishing activities. Another goal of the management plan is the need to protect the Park's unique fish population. In order to set regulations, initial monitoring and an inventory of basic resources are needed for baseline data. Hattie Cove was a priority site for this study because of its location (easy access) in relation to fishing pressure and its uniqueness as to the size of which pike can achieve as stated in the Sport Fish Management Plan for Pukaskwa National Park (Schiefer et. al. 1986).

There is a need for fishing regulations. The theory behind this is that the Park presently follows the provincial guidelines in catch limits and seasons. According to the Ontario Sport Fishing Regulations Summary (OMNR 1990), the Park is included in Division 19 for interior waters and Division 23 for Lake Superior waters. The physical, chemical and biological resources, and fishing pressure vary from one body of water to the next, therefore, one type of regulation is not enough to protect/manage these bodies of water (Schiefer et. al. 1986). Once the Park is Gazetted, the enforcement of National Park Fishing Regulations would apply.

In order to manage and impose fishing regulations, a resource inventory is needed as a basis for management in Hattie Cove.

A Study Design For Aquatic Resources Inventory, Hattie Cove, Pukaskwa National Park (Moreland 1988) by was prepared as a methodology for carrying out the resource inventory. These study design guidelines, in conjunction with Beak Consultants' comments were used as basic methodology.

John Kelso, Department of Fisheries and Oceans, Sault Ste. Marie provided valuable training and guidance for the Ultra-Sonic Telemetry component of this inventory.

Margo Shaw and Glen Forward from the Department of Fisheries and Oceans, Sault Ste. Marie also provided their guidance in the collection and processing of benthos samples. The identification of the samples was contracted out to W. B. Morton, of Guelph, Ontario.

A screening report (Vien 1988) was prepared prior to the study. Mitigative measures of anticipated impacts which may occur during the collection of data were outlined.

3.0 METHODOLOGY

3.1 General Inventory - Map work.

All maps were produced on a scale of 1:2000 from Hattie Cove Area Development Plan, Pukaskwa National Park (Parks Canada 1986). There were five maps produced: a) Base Map, b) Bathymetric map, c) Land Type Map, d) Shoreline Soil Type, and Terrestrial Vegetation Map, and e) Aquatic Resources Map.

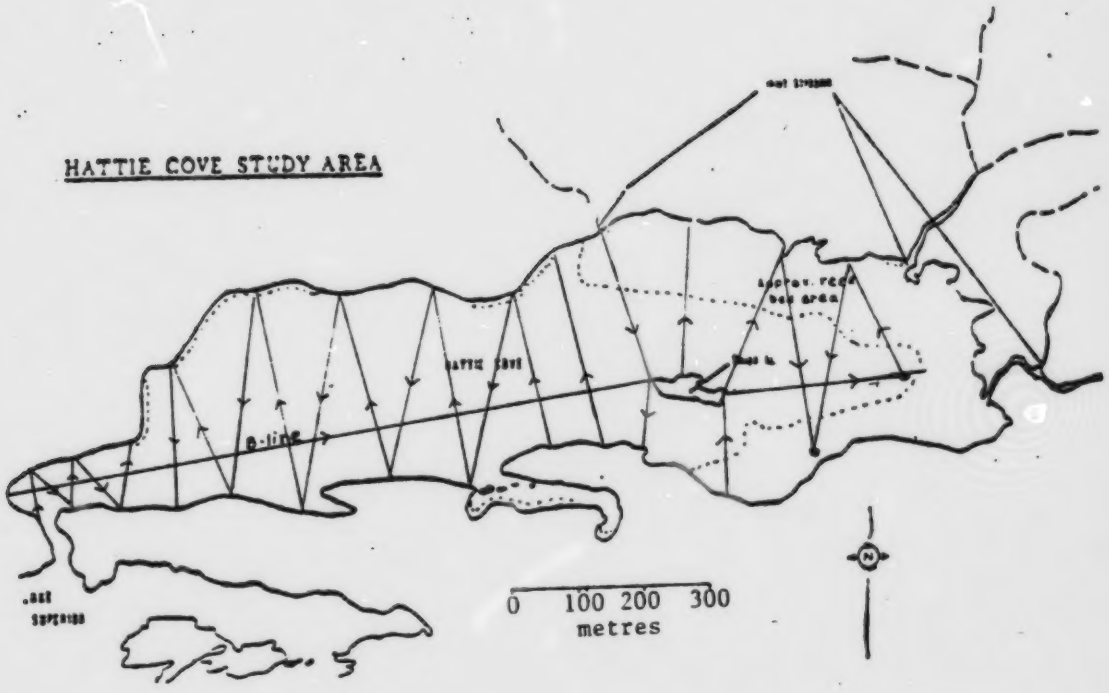
A) Base Map

The base map was reproduced from the existing 1:2000 maps obtained from the Hattie Cove Area Development Plan, Pukaskwa National Park (Parks Canada 1986). An outline of Hattie Cove, the directional flows of all creeks, North Arrow, water level bench mark location with UTM coordinates, & location of all roads, trails and bridges were included in the base map.

B) Bathymetric Map

A Lowrance depth finder was used to record the water depth in order to produce the bathymetric map on September 12 and 13, 1988. The exploratory line (B-Line) which extended the length of the cove was used to determine the maximum depth. Depths along traversing transect lines were also recorded (Figure 1). The depth sounder gave readings in feet and therefore had to be converted to metres out of the field. A water level benchmark (BM) was established at UTM coordinates EJ 527818 at a height of 184.06 metres. The level of the water was calculated by obtaining the Marine Forecast

FIGURE 1 Traversing Transect Lines for Bathymetric Map



(MAFOR) readings and placing the benchmark 1 metre above the water line for that day. The Lake Superior Chart Datum was 182.9 metres. The BM was established on September 14, 1988 and the water level was 0.16 metres above Chart Datum. Therefore the water level BM for Hattie Cove was 182.9 metres plus 0.16 metres and 1.0 metres which equalled 184.06 metres. The BM is a chiselled mark (approx. 10 x 1.0 cm) on the surface of a vertical rock face (Photographs 1 and 2). The mean water depth was calculated, as well as the volume and area represented by each 2 metre interval. The surface area of each contour line area was calculated by using a grid paper with .25 cm^2 squares. The bathymetric map was traced onto it and the squares were counted for each depth range. The total lake volume and mean depth were then calculated (OMNR 1984):

$$\text{Total lake volume} = \frac{hi}{3}\left(a_1+a_2+\sqrt{a_1 \cdot a_2}\right) + \frac{h}{3}2\left(a_2+a_3+\sqrt{a_2 \cdot a_3}\right) + \ldots$$

h = horizontal stratum - depth of 2 metres
a = area of each contour line
volume = 10^4 m^3
The mean depth (s) in metres: $s = \frac{v \quad (10^4 \ m^3)}{a \quad (ha)}$

The calculations were included in Appendix D.

C) Land Type Map

This map was reproduced to a scale of 1;2000 from: Canadian Forestry Service, Forest Management Institute Land Type Map (1974), Map 42 D/9 c-d.

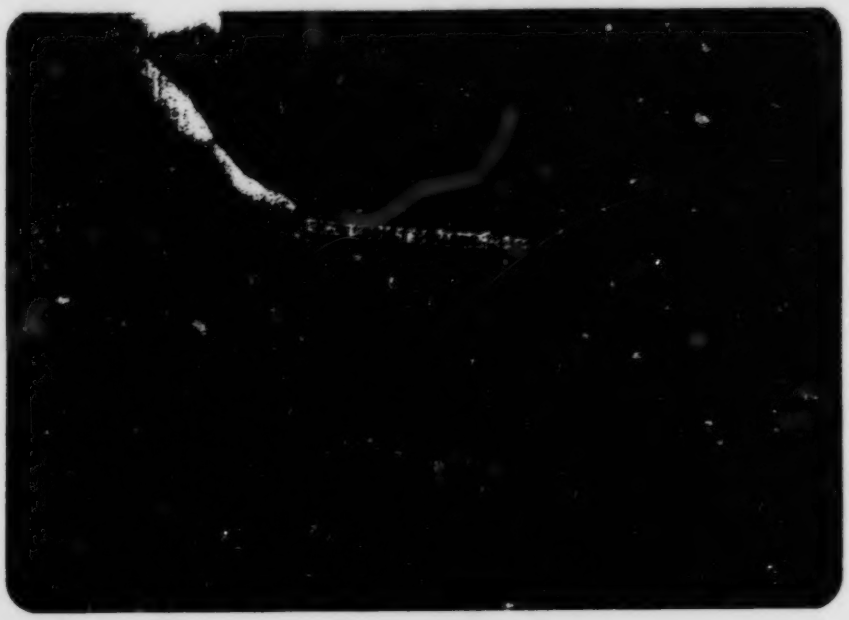
D) Shoreline Soil Type, & Terrestrial Vegetation Maps

These maps were reproduced at a scale of 1:2000 from Pukaskwa Hattie Cove Vegetation map, and Pukaskwa Hattie Cove Slopes map which were prepared for Parks Canada by Airphoto Analysis Associates (1975). The shoreline soil type was determined by carrying out a shoreline cruise. A shoreline description was mapped with identification of the major shorelines soil types according to: bedrock, boulders, rock rubble (3-20 cm diameter), gravel (<3 cm diameter), sand, muck, marl and detritus.

E) Aquatic Vegetation Map

An aquatic plant survey was carried out on September 2 and 3, 1989. A field map was used to sketch the location of the abundance of each type of plant according to denseness of the growth. These descriptions were visual

PHOTOGRAPH 1: Water Level Bench Mark



PHOTOGRAPH 2: Location of Water Level Bench Mark

observations made by one person and every attempt was made to ensure these descriptions remain constant. The plants were given a letter to represent the species and coded according to the abundance by using number 1: sparse, 2: common, and 3: dense. When the observer noticed a new species was found in the area, and /or the abundance changed, the area on the field map was sectioned off and a new one created. Attempts were made to locate Torrey's Bulrush (Scirpus torreyi). It was once considered a rare species in Ontario (Ecologistics 1979), but was subsequently deleted from the Park's rare plant list (Parks 1986). The plants collected were placed in a moistened plastic bag for use for the second day of field aquatic vegetation mapping. After the collection was made, the plants were blotted between newspaper and changed daily to prevent moulding. The plants were identified to the family, genus, and most to the species level. These plants were kept for future reference. The final map was produced at a scale of 1:2000, depicting each species and abundance.

3.2 Water Quality

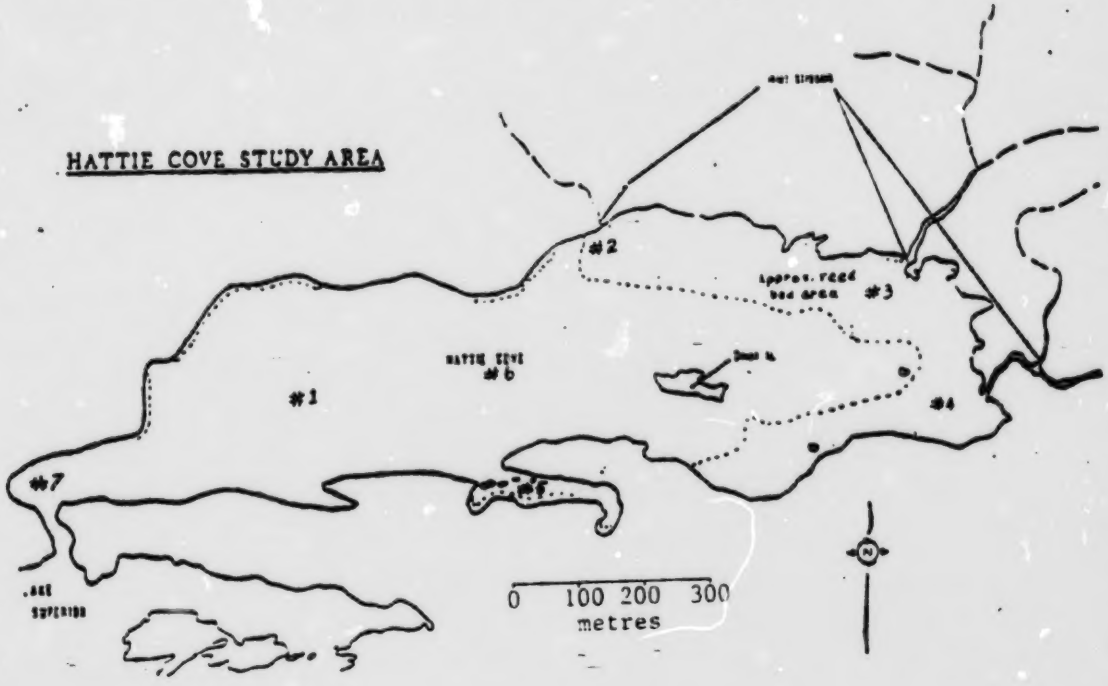
Information obtained for water quality include: dissolved oxygen (mg/l) and Temperatures (c^{o}) at every metre, pH, and specific conductivity at the surface, middle and bottom depth. The mean secchi disc depth was also recorded. Sediment samples were collected in February, 1989.

List of equipment used for Water Quality Analysis:

- secchi disc
- Fisher pH/Temperature Meter 119
- YSI model 54A Oxygen Meter
- stainless steel Ekman grab
- Kemerer water sampler
- glass jars
- specific conductivity meter
- pencils
- tally sheets
- whirl pacs
- magic marker
- plastic spoon
- dry thermometer
- YSI telethermometer
- power auger

The locations of water quality sampling sites were indicated in Figure 2. Water quality testing was carried out during the afternoon of February 7, 1989 and October 1, 1989.

FIGURE 2 Water Quality Testing Sites



Stations 1 to 5 were tested on February 7, 1989. The weather was overcast, -5.0° Celsius, with light blowing snow. An ice auger was used to drill holes in the ice. Water quality testing on October 1, 1989 were at approximately the same places, plus stations 6 and 7 were added. The weather for this day was clear, 15° Celsius with southwest winds of 25 km/hr.

The sediment samples were collected on January 7 and 8, 1990. The weather was overcast, plus 2° Celsius, with southwest winds at 10 km/hr. Figure 3 maps the sediment sample location sites.

Surface sediment was obtained at 2 inlet streams, mouth of Hattie Cove to Lake Superior and the main basin. Sediment below the sediment/water interface was also obtained from the main basin. Table 1 lists the depth of ice and water at each location. Due to the depth of the water at the back of the cove, the two streams were completely frozen, therefore, a single sample (#3) was obtained in the vicinity of one of the streams. Holes in the ice were made with a power auger. Caution was maintained to make certain that the sediment would not be disturbed. Samples obtained at the mouth of Lake Superior/Hattie Cove were from an aluminum boat.

There were a total of 4 sites of sediment samples. These samples were labelled and kept frozen. The sediment was sent for analysis for trace metals to Inland Waters Directorate, Water Quality Branch, Burlington, Ontario on February 7, 1990.

3.3 Benthic Fauna

The littoral mapping was carried out on August 9, 1989 to determine the station locations of the 0.5 m^2 sweep samples. These areas were identified as sand, rush, submergent vegetation, lily pads, and rock in order to cover concentrated areas of microphyte for pike nursery habitat. From each station, 3 randomly sampled replications were taken with a 500 micro unit screen net. A total of 15 sweep samples were obtained. The profundal zone sampling was carried out on August 10, 1989. Three sample sites were required at depths of 10 m, 8 m and 5 m. The actual locations were taken at 9.25 (ave), 6.2 m (ave), and 2.75 m. A 6" x 6" (9" tall) Ekman dredge was used to collect the total of nine dredge samples. Figure 4 illustrates the locations of the sweep and Ekman samples. These sites were described in Table 2.

The processing of the samples was carried out in the lab. All samples were sieved through a 500 micro unit

FIGURE 3 Sediment Sample Sites

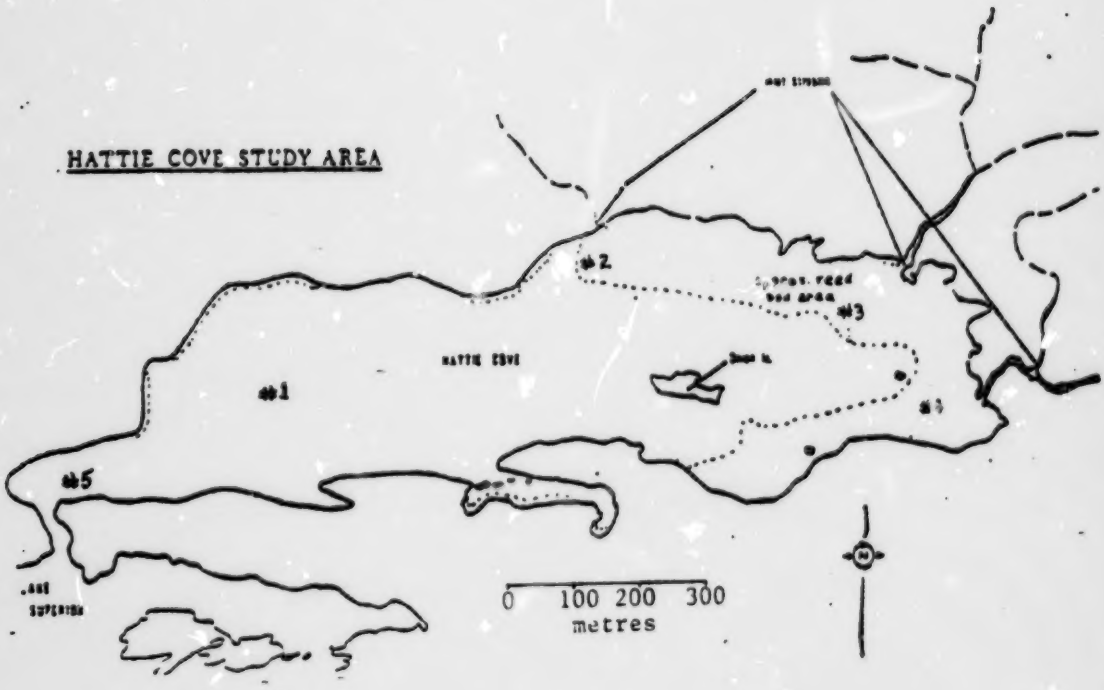


Table 1 Depth of Water and Ice at Sediment Sample Sites

SEDIMENT SAMPLES FOR HATTIE COVE

DATE	SITE #	REP #	DEPTH OF WATER	DEPTH OF ICE
07/01/90	1	1 Surface	8 m	55 cm
07/01/90	1	1 Bottom	"	"
07/01/90	1	2 Surface	"	"
07/01/90	1	2 Bottom	"	"
		All surface		
07/01/90	2	1	1.2 m	38 cm
07/01/90	2	2	"	"
07/01/90	3 (4)	1	1 m	34 cm
07/01/90	3 (4)	2	"	"
08/01/90	5	1	0.75 m	n/a
08/01/90	5	2	"	"

Note: site (4) was frozen.

FIGURE 4 Sweep and Ekman Sample Sites

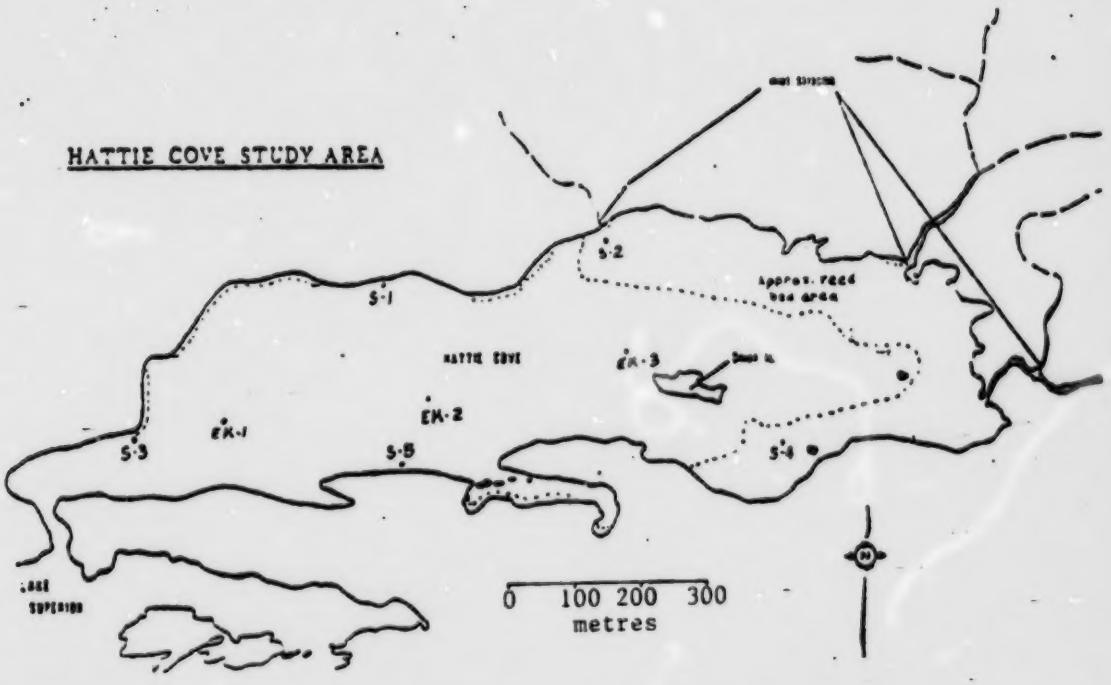


TABLE 2 Description of Sweep and Ekman Sample Sites

Site #		Substrata	Depth of Water At Sample Site
Sweep 1		Sand	0.35 m
Sweep 2		Emergent Plants	0.57 m
Sweep 3		Submergent Plants	0.80 m
Sweep 4		Nuphar Beds	0.78 m
Sweep 5		Rocks	0.92 m
		Depth Represented	
Ekman 1	rep 1	9 m	9.50 m
	rep 2	9 m	9.00 m
	rep 3	9 m	9.25 m
Ekman 2	rep 1	7 m	6.50 m
	rep 2	7 m	6.50 m
	rep 3	7 m	5.50 m
Ekman 3	rep 1	3 m	2.75 m
	rep 2	3 m	2.75 m
	rep 3	3 m	2.75 m

mesh size container. The organisms were picked live and preserved in 10% Formalin solution. Samples that could not be picked within 24 hours were preserved in 70% Ethonol and Rose Bengal solutions. These samples were picked at a later date, then preserved in 10% Formalin solution.

Identification of samples were contracted out to a biologist. Appendix A contains a field and lab summary, the Terms of Reference for Benthos Sample Identification and the report of Benthos Sample Identification for Hattie Cove, Pukaskwa National Park, 1989.

3.4 Minnow Trapping

Minnow traps (10) were set and checked for 3 consecutive days, from August 9/89 to August 11/89. The bait used were crackers for the first night and Meow Mix cat food for the second night. Most traps were set in 1 metre or less of water and a few at greater depths. All substrata (submergent vegetation, sand, rush, lily pads, and rock) of Hattie Cove were sampled for minnows. Figure 5 shows these locations.. The cat food bait was taken out of the traps and removed from the Cove when the traps were pulled.

3.5 Fish Tagging

Fishing tagging, was carried out in the fall of 1988, and again in the fall of 1989. Three trap nets (Figure 7 Trap Net - Hoop Style) were used at different locations during the fall of 1989. From October 6 to 26, the trap nets were checked every day and all pike, some large perch and some white suckers were tagged. A lot of fishing effort was put into this study and was ended due to the low number of pike being trapped. All fish to be tagged were anesthetized with baking soda and monitored for recovery before release.

Fish tagging was attempted once again in the fall of 1989. Gill nets were used to catch fish. The mesh sizes were 3", 4" and 5" inches. The dates the gill nets were set were Oct. 17, 18, 21, 24, 26, 31, Nov. 2, 4 and 6. The gill nets were not set in areas where birds were visible. Gill nets were closely monitored and checked every hour to prevent suffocating of fish. As a precaution, gill nets were moved to another location if a tagged fish or white fish were caught, in order to decrease stress on the pike and also white fish do not survive in the gill nets as long as most other fishes. All white suckers caught were released. Previously tagged fish (1988) were measured, weighed, and released. All pike were tagged with yellow coloured Floy Tags (type FD68BC) with the following information: "Return

FIGURE 5 Minnow Trap Sites

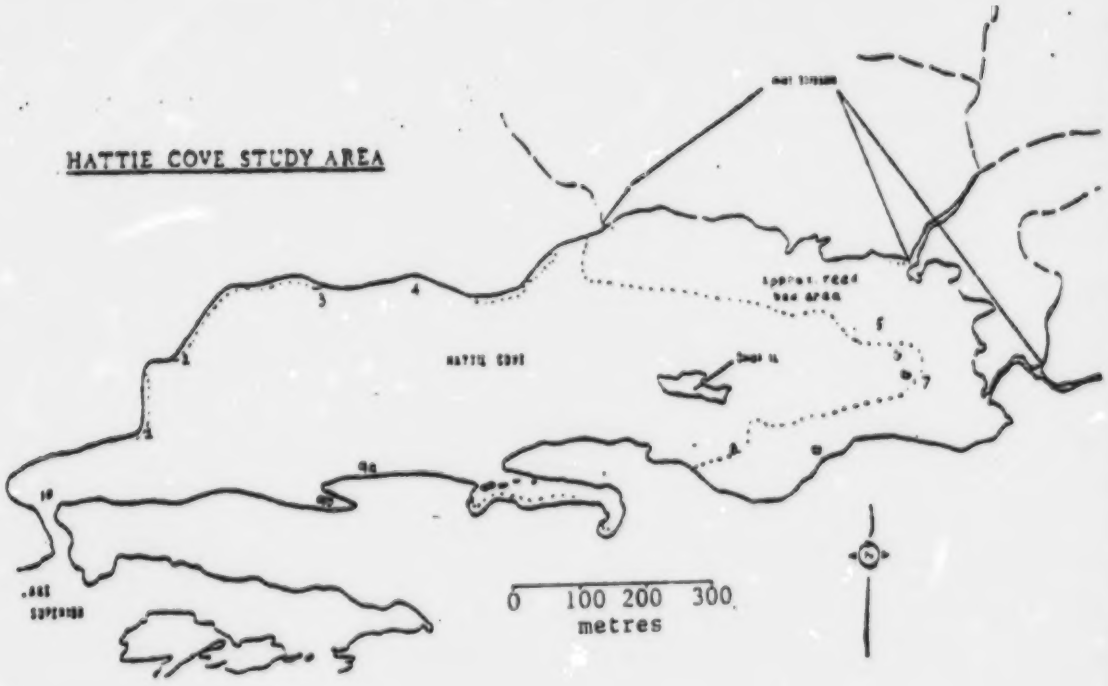


FIGURE 6 Lake Trap Net

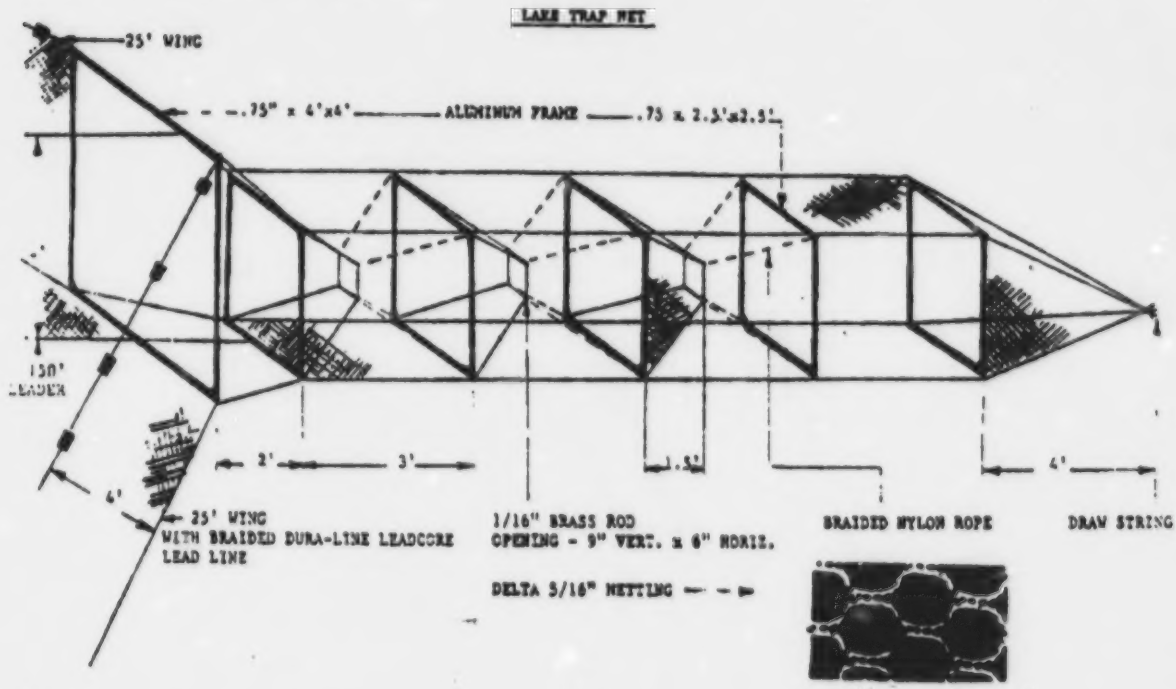
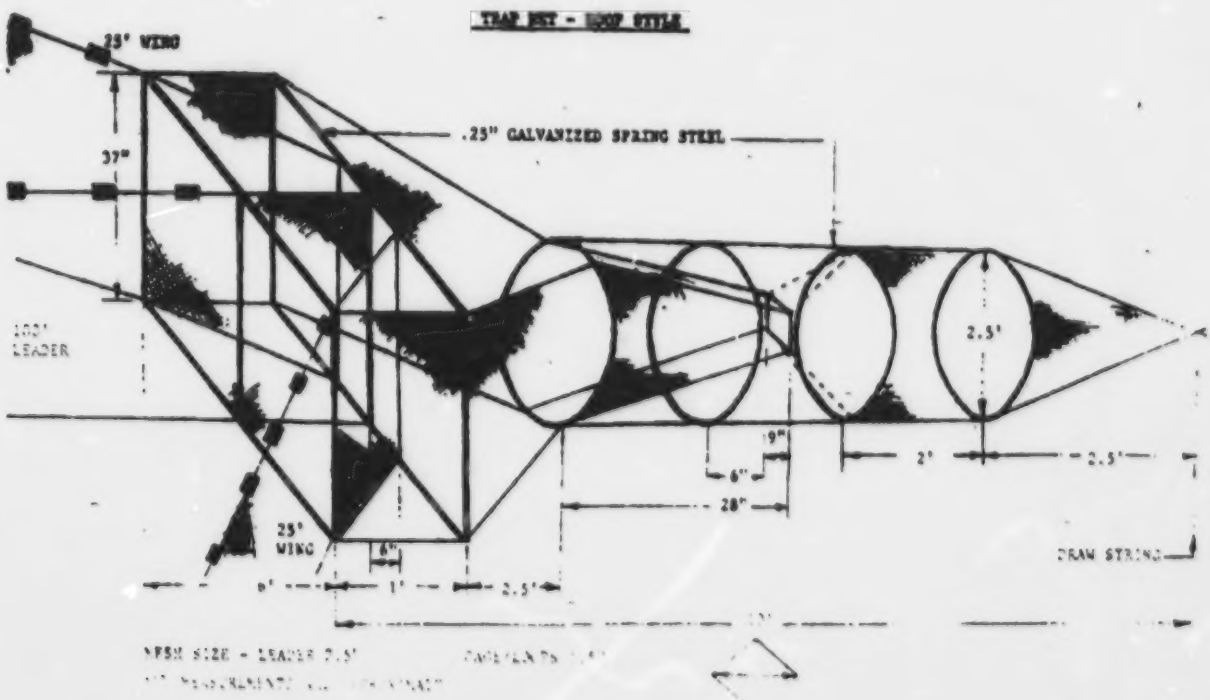


FIGURE 7 Trap Net - Hoop Style



catch info. to Pukaskwa National Park, Canada". The tag numbers start at 00001. The Floy Tag Mark II Pistol Grip Tag Gun was used to attach the tags to the flesh of the pike. The location of these tags were adjacent to the dorsal fin on the left side. A scale was lifted with the needle tip and tag was inserted forward through the dorsal rays . Appendix B contains a sample of the field Tally Sheets.

3.6 Ultra-sonic Telemetry

3.6.1 The surgical implantation of transmitters into 4 pike was carried out June 6, 1989 and one pike on June 20, 1989. Three trap nets (Figure 6 Lake Trap Net) were set on June 5, 1989. Two nets were set in the shallow weedy area of the east end of the cove, and one near Onion Island in deeper water. No pike were caught however and because of the mesh size, many minnows were caught and released (re: to the results for minnow trapping). Due to time restraints,"experimental" gill nets were used and were checked every hour with good results. Injured pike were measured, tagged and released. No anesthesia was used to surgically implant the transmitters into healthy pike.

The instruments used in the surgical procedure include:

1) C-9 Dexon 1/2 circle taper point, polyglycolic acid suture, synthetic absorbable sterile, braided suture.

2) Feather scalpel with #11 blades.

3) Sponge sheet (to protect the fish's skin/scales)

4) Trough with measure rule.

5) Tissue forceps

6) Forceps

7) Scissors

8) Alcohol (isopropyl) and tray

9) Holding buckets

10) Paper towels

11) Transmitters (Sonotronics, Tucson, Arizona):
- sealed in paraffin and a plasticizer formula
- dimensions: 67 mm long 18 mm diameter
- air weight of 21.7 g
- frequencies 75 and 78 KHZ

All instruments and transmitters were cleaned in alcohol on site. Implantation was carried out in the field.

The unanesthesized pike were wrapped in a wet sponge, placed in a trough and measured on its back. The scalpel was used to make an incision ventrally below the pectoral fin and slightly to the side. The scissors were used to lengthen the incision to about 22 mm. Care was taken to avoid damage to the internal organs. The transmitter was inserted and the incision was sutured. The pike was placed in a fresh container of water and monitored for a recovery period, then released. Photographs 3 through 8 provide a visual description of the surgical process.

3.6.2 Tracking was carried out daily with the use of an ultra-sonic receiver (with hydrophone and earphones). Access around the cove was accomplished by canoe, and a battery operated motor (Minn Kota 65 mx) during windy days.

Directional locations were sketched onto field maps. These were later compiled as to days pike were not found in the cove, and their movement around the cove on a day to day basis.

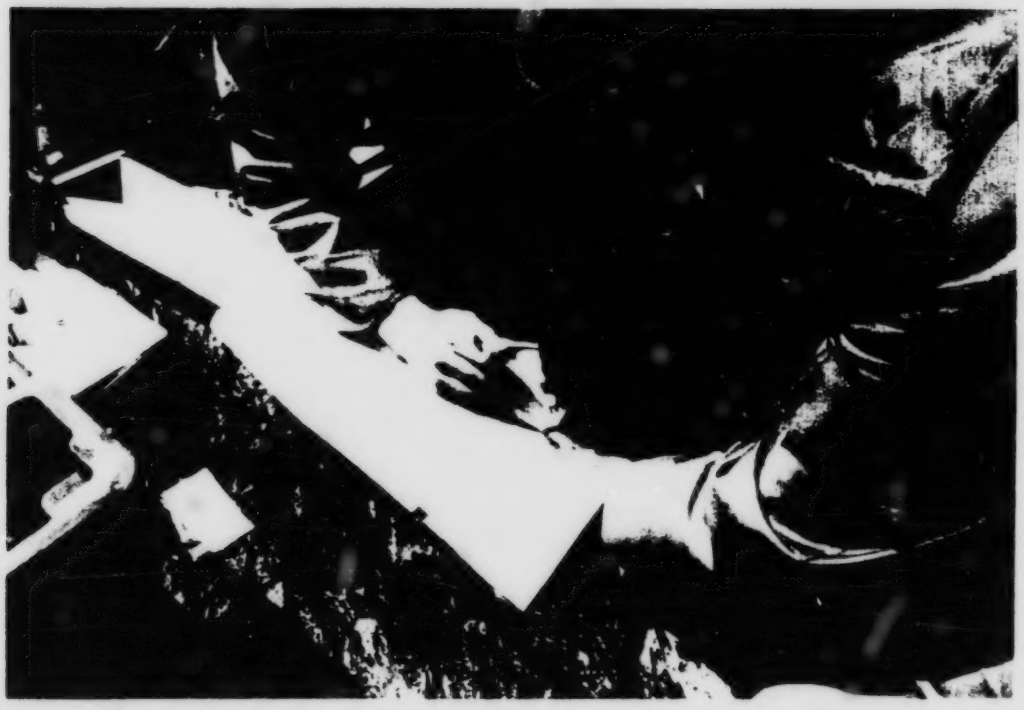
3.7 Creel Census

There were two types of creel census carried out for Hattie Cove. One form was used (Appendix B) to accommodate both the stratified and random creel census.

The stratified creel census was carried out twice daily, once between 0700 and 1200 hrs and once between 1200 and 1700 hrs. Each stratified creel census lasted for one half hour, at any time during these two periods. A number of different persons carried out the creel census and it was to their discretion as to the timing. Surveying during routine daily duties were discouraged due to biasing the timing. For example, a bias would be created based on saying that there are no fishermen in the cove during the summer at 0900 hours which was the usual time for backcountry registration check.

PHOTOGRAPH 3 MEASUREMENT OF PIKE
Pike is measured for total length and is recorded.

PHOTOGRAPH 4 SURGICAL INCISION
Incision is carefully performed below the pectoral fin without damaging the internal organs.

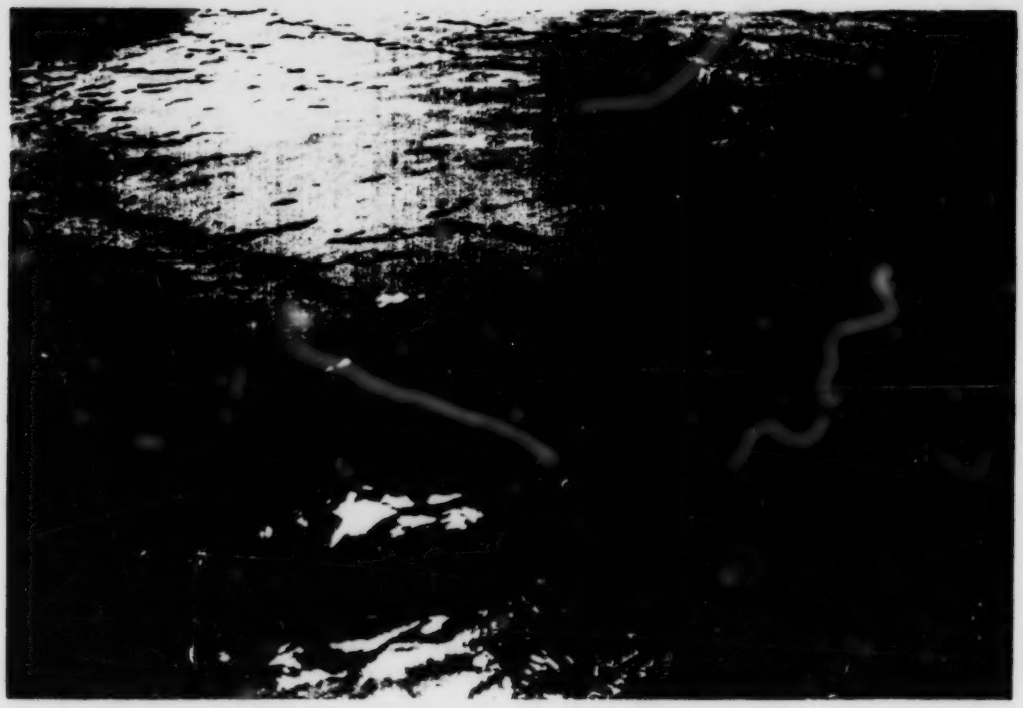


PHOTOGRAPH 5 TRANSMITTER INSERTION
Transmitter is being inserted.

PHOTOGRAPH 6 TRANSMITTER INSERTION
Transmitter inserted and will be moved to the mid-section of the body cavity.

PHOTOGRAPH 7 SUTURING THE INCISION
The incision is sutured immediately after transmitter implantation.

PHOTOGRAPH 8 RELEASE OF SURGICALLY IMPLANTED PIKE
Pike is monitored for recovery and then released.



The random creel census was carried out at times other than the stratified creel census when fishermen were noticed in the cove especially after 1700 hours.

The information obtained were: date, time, surveyors' name(s), weather, indication of resident, non-resident (Canadian), non-resident (other nations) and Robinson Superior Treaty Groups, number of persons fishing in the party, time spent fishing, # of fishing lines, type of bait, and location on the map. The species were noted by type, total length, forked length, standard length and weight, scale samples were taken (for age determination), and tag number was noted (if one attached), also during the winter creel, tissue samples were obtained from some pike to be analyzed for mercury. The location of fishing was also indicated on the field map on the opposite side of the creel sheet.

There were 2 seasons for the creel census survey. The Ice Fishing creel for 1989 includes the following dates: January 14 - April 23, and November 19 - January 13. The non-ice fishing creel (rods and reels) extend from June 24 to November 18, 1989. The dates from April 24 to June 23 were not included because ice melt conditions prevented ice fishermen from going onto the cove, and visitor season for the summer had not yet started.

The information gathered was entered into a computer program. Appendix C contains a breakdown of and an example of the formulae used in compiling the data.

3.8 Mercury Analysis

Tissue samples were obtained from fish caught during the creel census. A ten gram plug of tissue was removed from the area immediately behind the gills. Ten samples were analyzed.

4.0 RESULTS

4.1 Maps - General Inventory

All maps produced to a 1:2000 scale were included in the back sleeve of this report

Figures 8 and 9 illustrate differences between the 1974 field map and the updated one. These include the differences as to the extent of the reed bed, as well as the number of inlet streams. When the inlet streams were searched for, only one on the north side was found.

FIGURE 8 1974 Field Map

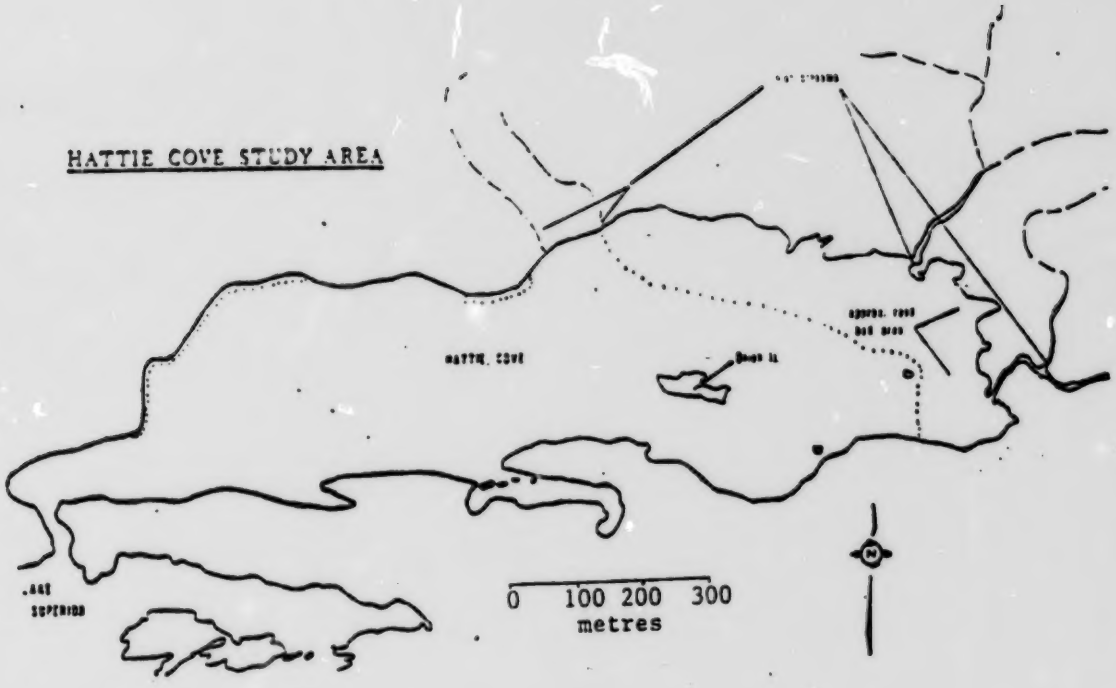
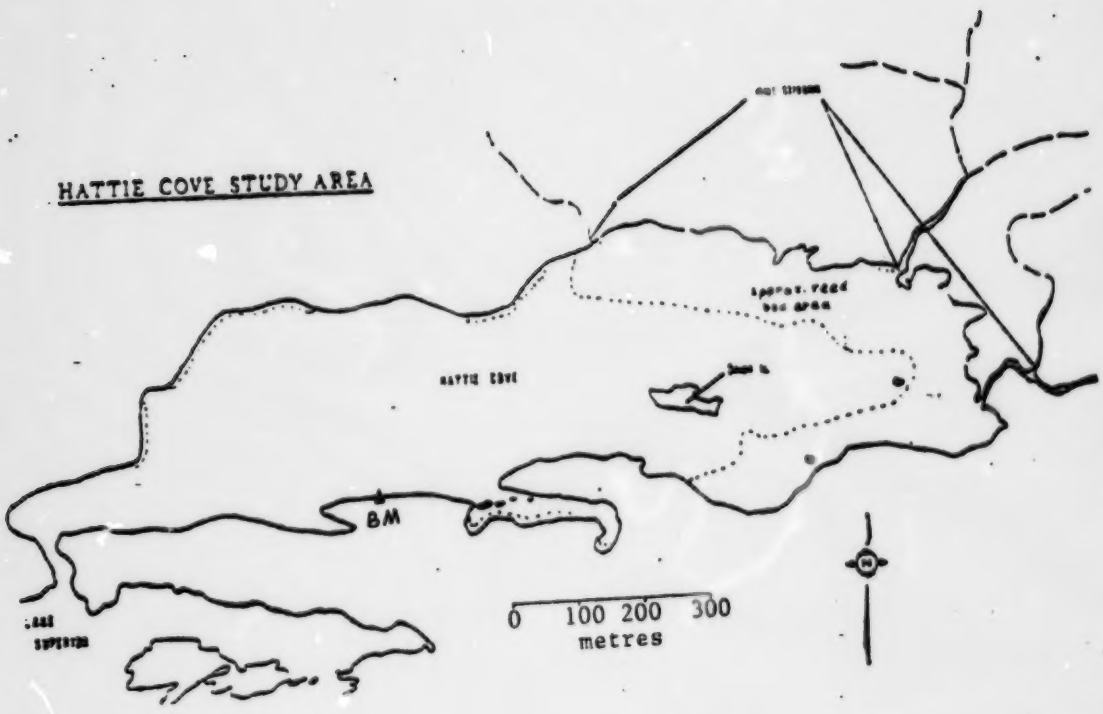


FIGURE 9 1989 Field Map



A) Base map - The information was obtained from the Hattie Cove Area Development Plan, Pukaskwa National Park (Parks Canada 1980). This also showed one inlet stream on the north side of Hattie Cove. The location of the water level Benchmark in Hattie Cove was included.

B) The Bathymetric Map - The area of each contour interval of 2 metres was calculated with the use of grid paper (0.25 cm^2 squares).

The following was the result of the area in hectares of each contour interval.

0 - 2 metres	=	19.59 ha
2 - 4 metres	=	4.68 ha
4 - 6 metres	=	5.57 ha
6 - 8 metres	=	2.80 ha
8 -10 metres	=	3.97 ha
10 +	=	1.12 ha
Total surface area	=	37.73 ha

Appendix D contains the calculations used to obtain the following volumes for each stratum and the mean depth.

Stratum 1)	surface to 2 metres	$= 54.68 \times 10^4\ m^3$
2)	2 metres to 4 metres	$= 31.48 \times 10^4\ m^3$
3)	4 metres to 6 metres	$= 21.10 \times 10^4\ m^3$
4)	6 metres to 8 metres	$= 12.88 \times 10^4\ m^3$
5)	8 metres to 10 metres	$= 5.73 \times 10^4\ m^3$
6)	10 metres to 10.7 metres	$= 0.38 \times 10^4\ m^3$
Total volume of Hattie Cove		$126.25 \times 10^4\ m^3$

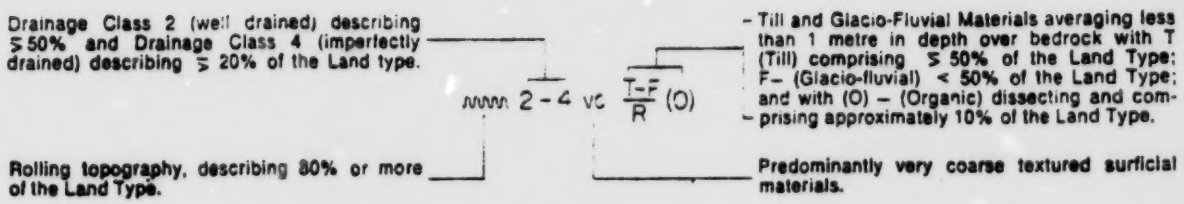
The mean depth of Hattie Cove was 3.35 metres.

C) Land Type Map - Figure 10 should be used when reading this map in order to better interpret the percentage of the land types. The area of land near the day use area (west, north aspect of Hattie Cove) is described as undulating, drainage ranging for moderately well drained describing $\geq$ 50%, and rapidly drained $\geq$ 20% of the land type more than 80%. The texture class is mainly very coarse textured surficial material of aeolian ($\geq$ 50) and waterlaid materials.

FIGURE 10 Land Type Legend

LAND TYPE LEGEND

SAMPLE SYMBOL


Drainage Class 2 (well drained) describing ≤ 50% and Drainage Class 4 (imperfectly drained) describing ≤ 20% of the Land type.
Till and Glacio-Fluvial Materials averaging less than 1 metre in depth over bedrock with T (Till) comprising ≤ 50% of the Land Type; F– (Glacio-fluvial) < 50% of the Land Type; and with (O) – (Organic) dissecting and comprising approximately 10% of the Land Type.
wwm 2 - 4 vc T-F/R (O)
Rolling topography, describing 80% or more of the Land Type.
Predominantly very coarse textured surficial materials.

Note: DRAINAGE

a) A single Drainage class describes 80% or more of the Land Type.
b) Two consecutive Drainage Classes (ie: 2-3) combined describe 80% or more of the Land Type with the first being dominant.
c) Two non-consecutive Drainage Classes (ie: 3-5) combined describe 70% or more of the Land Type with the first Drainage Class describing ≤ 50% and the second ≤ 20% of the Land Type.
d) <10% of a Land Type area may be any other Drainage Class.

Note: SURFICIAL MATERIAL

a) A single Material alone (or alone over bedrock or other Material) describes ≤ 80% of the Land Type.
b) Two Materials separated by a hyphen combined describe ≤ 80% of the Land Type with the first representing ≤ 50%.
c) A Material occurring in brackets at the end of the symbol represents approximately 10% of the Land Type and significantly dissects the Land Type.
d) When bedrock is ≤ 80% and a texture and material follow in brackets, the bracketed portion significantly influences the character of the Land Type, making up < 20%.

The area along the north side, east of the day use area is also undulating, with well drained to imperfectly drained, moderately coarse sandy loam, 10% bedrock dissecting the glasio-lacustrine (> 50%), and organic material (< 50%) which averages less than 1 metre over bedrock.

The area immediately north of Onion Island, on the north aspect of the Cove is described as a simple slope, well drained to rapidly drained; moderately coarse sandy loam; with surficial material being mainly glacio-lacustrine (≥ 50%) and glacio-fluvial (<50%) which averages less than one metre over bedrock.

The far side of Hattie Cove (east end) is flat with eroded channels, poorly drained organic material. Beyond this, the topography is depressed, flat with eroded channels moderately well drained to imperfectly drained of moderately coarse (fine silty clay loam, clay loam, and sandy clay loam) organic (≥ 50%) and waterlaid (< 50%) surficial material which is less than one metre above glacio-lacustrine material.

The south east corner of Hattie Cove is high rolling, well drained, coarse (sand, loamy sand) glacio-fluvial (≥ 50%) to glacio-lacustrine (< 50%) materials which is less than 1 metre above bedrock.

The rest of the south side of Hattie Cove is undulating, rapidly drained to well drained coarse (sandy, loamy sand) glacio-lacustrine (≥ 50%) with bedrock comprising 10% on the surface and is also less than 1 metre below the glacio-lacustrine.

In summary, the areas facing north and south of Hattie Cove are mainly bedrock with glacio-lacustrine of coarse to very coarse material which at least is well drained. The far east is flat with eroded channels and poorly drained organic material. The west side is undulating with rapidly drained, very coarse, aeolian and waterlaid materials to poorly drained glacio-lacustrine and organic matter over bedrock.

D) Terrestrial Vegetation, Slope and Shoreline Type Map

The surrounding terrestrial land was described as:

> To the east - a flooded carex marsh with the average height of 0 - 2 metres with a slope of 0 - 2%.

To the south side and northeast aspect a 41 - 70% cover of a natural black spruce-sphagnum forest of 40 - 70 years, 5 - 20 metres in height. The slope class ranges from 25% to 0 - 2% in a small low lying area.

The northeast area - ranges from an aspen herb forest (10 - 30 years) to a white spruce (30 - 70 years) to a rock heath, and also to a black spruce moss stand (50 - 120+ years).

The shoreline type is mainly sandy along the north side of the cove and in front of the day use area. The far east is mud, muck and organic matter. The south side is mainly bedrock with scattered boulders, rock and rubble. The bay on the south side is made up of mainly mud, muck and organic matter, with sand and some rubble.

E) Aquatic Vegetation Map - Table 3 is a list of species identified in Hattie Cove, however, these were NOT verified by a professional botanist.

During the survey, Torry's bulrush (Scirpus torreyi) was not found in Hattie Cove. Ecologistics (1979) had referenced this species as rare, but was deleted from the rare plant list in the Rare Plant Management Plan (1986).

The list of species was compared to those listed in the Rare Plant Management Plan (Environment Canada Parks 1986) and the Rare Vascular Plants of Ontario (Argus and White 1977) Argus and White identified wild rye (Elymus mollis Trin) as a rare plant in Ontario with a disjunct population along Lake Superior. The Rare Plant Management Plan (Environment Canada Parks 1986) also classified this plant Priority III, which requires a moderate need for attention. Wild rye was considered rare in this province and Canada. It was described to be located mainly in the sand dunes of the Hattie Cove area, but interesting to find it also along the sandy shore of Hattie Cove.

Ecologistics (1979) also stated that the marsh at the east end of Hattie Cove is dominated by Bluejoint Grass (Calamagrostis sp). This plant was not identified during the plant collection.

It should be noted that the information for this list of species and map was conducted on September 3, 1989 and a lot of plants were missing identifying features, such as flowers.

TABLE 3 LIST OF AQUATIC PLANT SPECIES FOR HATTIE COVE

FAMILY	GENUS - SPECIES
ALISMACEAE	Sagittaria latifolia Willd. broad leaved arrowhead
CALLITRICHACEAE	Callitriche L. water starwort
CYPERACEAE	Eleocharis palustris (L.) R. & S. spike rush
	Carex aquatilis Wahl. sedge
	Scirpus validus Vahl. great bulrush
CERATOPHYLLACEAE	Ceratophyllum demerson L. coontail
EQUISETACEAE	Equisetum arvense L. common horsetail
	Equisetum fluvatile L. horsetail
GRAMINEAE	Agrostis stolonifera L. red top
	Elymus mollis Trin. wild rye
	Glyceria canadensis (Michx.) Trin. rattlesnake grass
HALORAGIDACEAE	Myriophyllum alterniflorum DC. water milfoil
HYDROCHARITACEAE	Anacharis nuttallii Planche. water-weed
	Vallisneria americana Michx. tapegrass/wildcelery
NAJADACEAE	Potamogeton crispus L. curly pondweed
	P. foliosus Raf. leafy p.
	P. gramineus var gramnifolia F. longipedunclatus common p.
	P. gramineus var graminifolius common p.
	P. Richardsonii (Benn.) Rydb. Richardson's p.
	P. robbinsii Oakes. fern p.
NYMPHAEACEAE	Nuphar variegatum Engelm. yellow water lily
RANUNCULACEAE	Ranunculus aquatilis L. white water buttercup/crowfoot
	R. cirinatus Sibth. white water crowfoot
SPARGANIACEAE	Sparganium minimum (Hartm.) Fries lesser burreed

4.2 Water Quality

Figure 2 illustrates the locations of the Water Quality Analysis stations. Table 4 lists each of the stations with the results obtained at every one metre depth and/or mid depths. The diagrams represent the cross section of each station to the depth of ice and water for the February, 1990 results and break to show the results for October, 1990. Since the field locations were not marked in Hattie Cove, the approximate locations were sampled in October. Some of the October samples had a difference in water depths.
Figure 3 illustrates the station locations for sediment sampling which were carried out on January 7 and 8, 1990.

Table 1 lists the depth of water and ice for each sediment sample location. The samples were sent to a lab for analysis and the results have not yet been obtained. These will be included as an addendum to this report.

The east shallow end was completely frozen over in February, therefore there were no results for water quality analysis in this area. Sample sites 6 and 7 were added for the October date for additional baseline data.

The February water temperatures for Hattie Cove include the following: completely frozen water at the east shallow end, 0.0° in the small bay (.5 m water under 47 cm ice) and 0 to 1.0° in the basins of the cove. For the October results, the east side of the cove ranged from 12.8 to 14.0 at the sample sites. However, the water temperature measured during telemetry tracking recorded up to 19° during the mid summer in the shallow water of approximately 50 cm. The October temperature for the main basin ranged from 12.0° to 11.5° (surface to 8.9 m depth). No thermal stratification was noted during the October date.

The dissolved oxygen (mg/l) measured in February ranged from 12.4 (surface) to 0.7 (bottom) in the main basin, with 8.0 in the shallow bay. Dissolved oxygen in October ranged from 10.3 (surface) to 11.5 (bottom) in the main basin. The shallow areas (including the small bay) ranged from 9.5 to 10.4. Station 6 had readings from 10.2 to 10.4. Station 7 had 10.9 which was located at the entrance from Lake Superior to Hattie Cove.

TABLE 4: Water Quality Analysis Results

A: Feb. 7, 1989 Weather: -5.0c, overcast, light blowing snow
B: Oct. 1, 1989 Weather: 15.0c, clear, winds SW at 25 km/hr

STATION 1

Depth (metres)	Ice (cm)	Dissolved O2 (mg/ml)		Temperature (Celcius)		pH		Specific conductivity (microhmos/cm)	
	A	A	B	A	B	A	B	A	B
1.0	53	12.4	10.3	0	12.0	7.72	8.20	225	196
2.0		12.2	10.3	0	12.0				
3.0		12.1	10.3	0.5	12.0				
4.0		12.0	10.4	1.0	12.0				
5.0		11.8	10.4	1.0	12.0	7.68	8.20	200	179
6.0		11.4	10.3	1.0	12.0				
7.0		11.0	10.3	1.0	12.0				
8.0		10.8	10.3	1.0	11.5				
8.8		0.7	11.5	1.0	11.5	7.51	8.20	200	162

Secchi disc: 3.5 m

STATION 2

Depth (metres)	Ice (cm)	Dissolved O2 (mg/ml)		Temperature (Celcius)		pH		Specific conductivity (microhmos/cm)	
	A	A	B	A	B	A	B	A	B
1.0	44	N/A	10.3	N/A	12.8	N/A	8.12	N/A	157

Secchi disc: 1.5 m (see bottom)

TABLE 4: Water Quality Analysis Results (cont.)

STATION 3

Depth (metres)	Ice (cm)	Dissolved O2 (mg/ml)		Temperature (Celcius)		pH		Specific conductivity (microhmos/cm)	
	A	A	B	A	B	A	B	A	B
0.5	29	N/A	9.5	N/A	13.5	N/A	7.77	N/A	179

Secchi disc: 0.5 m (see bottom)

STATION 4

Depth (metres)	Ice (cm)	Dissolved O2 (mg/ml)		Temperature (Celcius)		pH		Specific conductivity (microhmos/cm)	
	A	A	B	A	B	A	B	A	B
0.5	29	N/A	10.0	N/A	14.0	N/A	7.98	N/A	185

Secchi disc: 0.5 m (see bottom)

STATION 5

Depth (metres)	Ice (cm)	Dissolved O2 (mg/ml)		Temperature (Celcius)		pH		Specific conductivity (microhmos/cm)	
	A	A	B	A	B	A	B	A	B
1.0	47	8.0	10.4	0.0	12.5	7.63	8.00	225	176

Secchi disc: 1.0 m (see bottom)

TABLE 4: Water Quality Analysis Results (cont.)

Station 6

Depth (metres)	Ice (cm)	Dissolved O2 (mg/ml)		Temperature (Celcius)		pH		Specific conductivity (microhmos/cm)	
	A	A	B	A	B	A	B	A	B
1.0	N/A	N/A	10.4	N/A	12.0	N/A	8.11	N/A	173
2.0	N/A	N/A	10.3	N/A	12.0	N/A			
3.0	N/A	N/A	10.2	N/A	12.0	N/A	8.12	N/A	173
4.0	N/A	N/A	10.2	N/A	12.0	N/A			
5.0	N/A	N/A	10.2	N/A	12.0	N/A	8.16	N/A	170
5.5 Bottom									

Secchi disc (x): 3.0 m

STATION 7

Depth (metres)	Ice (cm)	Dissolved O2 (mg/ml)		Temperature (Celcius)		pH		Specific conductivity (microhmos/cm)	
	A	A	B	A	B	A	B	A	B
1.0	N/A	N/A	10.9	N/A	11.5	N/A	829	N/A	168
1.5 Bottom									

Secchi disc: 1.5 m (see bottom)

The pH readings in February from the main basin for the top, middle and bottom depths were 7.72, 7.08 and 7.51 respectively. These were higher in October with results of 8.20 for the three depths. The February reading in the bay was 7.63 and increased to 8.00 in October. The October pH reading at the three sites located at the east end were 8.12, 7.77 and 7.98. The extra recordings in October are 8.11, 8.12 and 8.16 at 1 m, 2.5 m, and 5.0 m depths, (station 6) and a pH of 8.29 at the entrance of Hattie Cove from Lake Superior.

The specific conductivity (micromhos/cm) results were a direct reading from a specific conductivity meter. The surface, middle, and bottom depths were recorded. The main basin of Hattie Cove had respective readings of 225, 200 and 200 in February and lower readings of 196, 179 and 162 in October. The October readings for the shallow sites were 15 at 1 m, 179 and 185 at 0.25 m, and 176 at 0.5 m. The extra sites had readings of 173, 173 and 170 at 1 m, 2.5 m and 5 m depths. The entrance to Hattie Cove had a specific conductivity reading of 168 micromhos/cm. These results provide a base line datum for future aquatic surveys of Hattie Cove.

The secchi disc readings were not available during February as the water samples were obtained through a hole in the ice The mean secchi disc readings in October were: 3.5 metres in the main basin and 3.0 metres at station 6 (maximum depth of water was 5.5 m). The other sites were shallow enough to se the bottom which ranged from 0.5 to 1.5 metres.

The ice depth in February for the main basin was 53 cm. The shallow east end of the cove was frozen over with measurements of 44 and 29 cm. The ice depth in the bay was 47 cm.

4.3 Benthic Fauna

Figure 4 illustrates the locations for the 0.5 m^2 sweep and Ekman samples. Table 2 is a description of the sweep and Ekman sample sites.

From the Benthos Sample Identification for Hattie Cove, Pukaskwa National Park, 1989 (Appendix A), the following results were obtained. The sweep sample contained 57 taxa (43 at the family level only) which were characterized by: the amphipods, Hyallella and Gammarus, Lirceus linaeta (Isopoda), Sididae (Cladocera); gastropods; a variety of shallow water insecta (Ephemeroptera, Hemiptera, Trichoptera); Chrimomids; Oligochaetes (in low numbers); and Micropsectra, were almost non-existent. The Ekman samples contained 50 taxa which were characterized by chironomids. These were mainly Micropsectra, Oligochaeta with Tubificids, and some Diaporeia and Sphaeriidae. In comparison between the sweep and Ekman samples, the sweep samples were more diverse with 33 unique taxa. Table 5 is a summary of the Benthos Samples based on the 0.5 m^2 sweep and Ekman samples.

4.4 Minnow Trapping

Attempts to catch minnows were unsuccessful. Table 6 is a summary of the dates and time spent trapping at each location. These results were for two night sets at different locations around Hattie Cove. No minnows were caught. One crayfish (Orconectes virilis) was identified and released at site #2.

During the live trapping for pike in June, 1989 (Ultrasonic Telemetry), the following are a description of the minnows caught in those large traps (Figure 6 Lake Trap Net).

#1 shallow set	#2 shallow set	#3 deep set
40 minnows (shiners)	42 minnows (shiners)	no results
2 white suckers	1 white sucker (small)	
4 perch		

TABLE 5 Benthos Sample Summary

Type of Substrata	No. of Organisms	Wet Weight	Population Average per m^2
Site 1 Rep 1 sand	25	15.6 mg	$36/m^2$
Site 1 Rep 2 sand	10	2.4 mg	
Site 1 Rep 3 sand	19	13.9 mg	
Site 2 Rep 1 rush	134	74.6 mg	$321/m^2$
Site 2 Rep 2 rush	192	156.2 mg	
Site 2 Rep 3 rush	156	132.0 mg	
Site 3 Rep 1 submergent	54	149.9 mg	$226/m^2$
Site 3 Rep 2 submergent	77	177.4 mg	
Site 3 Rep 3 submergent	208	303.2 mg	
Site 4 Rep 1 nuphar beds	279	256.3 mg	$491/m^2$
Site 4 Rep 2 nuphar beds	150	326.8 mg	
Site 4 Rep 3 nuphar beds	308	1877.1 mg	
Site 5 Rep 1 rocks	31	18.1 mg	$113/m^2$
Site 5 Rep 2 rocks	23	14.5 mg	
Site 5 Rep 3 rocks	115	43.1 mg	

(Site 3 Rep 3 made up of 12 - Unionicola 2.4 mg. and 5 - Hydrachna 46.3 mg)

(Site 5 - Bryozoan colony on a chip of wood was not counted in the total sample, nor weighed.)

	Depth (m)	No. of Organisms	Population Avg. Per Ekman Site
Ekman 1 Rep 1	9.50	178	$152/.02\ m^2$
Ekman 1 Rep 2	9.00	107	
Ekman 1 Rep 3	9.25	170	
Ekman 2 Rep 1	6.50	34	$53/.02\ m^2$
Ekman 2 Rep 2	6.50	81	
Ekman 2 Rep 3	5.50	44	
Ekman 3 Rep 1	2.75	53	$92/.02\ m^2$
Ekman 3 Rep 2	2.75	133	
Ekman 3 Rep 3	2.75	90	

TABLE 6 Minnow Trap Sets Summary

Trap #	August, 1989 Date/Time	Bait	Date/Time	Results
1	9/1640	crackers	10/0952	0
2	9/1645	crackers	10/0948	crayfish (Orconectes virilis)
3	9/1648	crackers	10/0945	0
4	9/1650	crackers	10/0943	0
5	9/1653	crackers	10/0940	0
6	9/1655	crackers	10/0938	0
7	9/1656	crackers	10/0935	0
8	9/1659	crackers	10/0930	0
9a	9/1700	crackers	10/0928	0
10	9/1705	crackers	10/0925	0
1	10/1349	Meow Mix	11/0920	0
2	10/1352	Meow Mix	11/0930	0
3	10/1354	Meow Mix	11/0917	0
4	10/1357	Meow Mix	11/0935	0
5	10/1359	Meow Mix	11/0938	0
6	10/1401	Meow Mix	11/0940	0
7	10/1405	Meow Mix	11/0943	0
8	10/1410	Meow Mix	11/0950	0
9b	10/1416	Meow Mix	11/0955	0
10	10/1425	Meow Mix	11/0910	0

Other Observations - August 11/90
1 pike - approx. 3 lbs.
1 muskellunge - approx. 6 lbs.
3 white fish
School of common suckers
1 pickerel - approx. 5 lbs.
1 pickerel - approx. 5 lbs.

4.5 Fish Tagging

Table 7 lists the October, 1988 tagged fish of Hattie Cove which include the tag number (#1 = 00001, #2 = 00002, etc.), the date caught, the species, the standard (SL), forked (FL), and total (TL) lengths (cm), the weight (grams), and the assessed age (A) and calcified structure age (B). Table 8 lists those pike which were tagged in October, 1989. Figure 11 shows the success location sites where pike were caught during the live trapping.

In early October, 1988 pike were found at the east shallow end of Hattie Cove, whereas late October and early November, 1989 they were mainly caught closer to the entrance to Hattie Cove, particularly the shallow area east of the day use area. During the 1989 tagging, nets were set at different locations around Hattie Cove. Gill netting attempts at the south rocky side of the cove consisted of white fish which are more prone to suffocation than pike. Gill nets were immediately changed to another location to try for the preferred species of pike.

During the October, 1988 tagging, the trap nets were set overnight and checked twice daily. Seventeen pike were tagged during this time, none of which were recaptured pike. Due to time and manpower difficulties, the procedure was ended, with not enough information to estimate a population.

The tagging of pike was initiated again in late October, 1989. No pike were caught towards the east end of the cove. Two pike were recaptured from the previous year (No. 19 & 26). Twelve of the 19 pike caught were gill netted close to the Hattie Cove entrance to Lake Superior. Again, there were not enough recaptures to estimate a population.

Apart from the two recaptured pike during the 1989 tagging, one was caught by a fisherman in Hattie Cove in July, 1989. The pike tagged #17 had increased in total, forked and standard lengths by 1.5 centimetres. The weight had decreased from 4420 grams to 3500 grams.

TABLE 7 FISH TAGGING HATTIE COVE - 1988

TAG#	DATE CAUGHT	SPECIES	SL	FL	TL	WT(g)	AGE A	AGE B
1	Oct 6/88	Perch	27.0	29.5	30.5	210	6+	6+ (6)
2	Oct 7/88	N.Pike	43.0	46.5	49.5	640	2+	2+ (7)
4	Oct 13/88	N.Pike	25.5	28.0	29.0	140	1++	1++(7)
5	Oct 14/88	Wh. Fish	49.0	53.5	59.0	1560	12+	12+(7)
6	Oct 14/88	Common Wh Sucker	43.5	47.0	51.0	1260	8+	8+ (6)
7	Oct 14/88	Common Wh Sucker	41.5	46.0	49.0	1060	5+	5+ ??
9	Oct 14/88	Sucker	37.0	41.5	45.0	960	5+	5+ ??
10	Oct 14/88	Sucker	38.0	41.0	44.5	860	4+	4+ ??
11	Oct 15/88	Pike	58.0	62.5	65.0	1600	4+	4+(poor)
no tag	Oct 15/88	Wh Fish	17.0	18.0	20.0	100	1+	1+ (9)
12	Oct 16/88	Wh Fish	23.0	25.0	28.0	60	4+	4+ (7)
14	Oct 16/88	Wh Sucker	26.0	29.0	31.5	240	3++	3++(6)
15	Oct 16/88	Wh Sucker	36.0	37.0	40.0	460	3+	3+ (7)
16	Oct 17/88	Pike	75.5	79.0	87.5	3420	4++	4++(7)
17	Oct 17/88	Pike	79.0	81.5	85.5	4420	4+	4+ (7)
18	Oct 17/88	Pike	85.0	90.0	93.0	5920	8+	8+ (7)

A - Assessed age = the number of complete annuli present and the time of capture.
B - Calcified structure age; the actual number of annuli showing plus the edge condition i.e. 3++ 3 annulis with lots of growth
* - annulus on edge
o - annulus assumed to exist with edge
()- confidence rating from 1 - 10.

On Friday, 15 February 1991, a telephone call was received at the the Resource Conservation Office from a fisherman who had caught a Northern Pike at the mouth of the Pic River on Monday, 11 February 1991. The gentleman had found a tag from the Park's aquatic survey attached to the fish. He was able to provide the following information:

Tag No.: 00023
Species: Northern Pike
Location: Mouth of the Pic River
Weight: 2270 grams (approximately)
Remarks: The tail of the fish was damaged. The overall length of the fish was 65 cm.

According to Table 7 (page 39) of the Aquatic Resources Inventory for Hattie Cove: Pukaskwa National Park (Odjick: 1990) the fish tagged with tag no. 23 was tagged on 17 or 18 October 1988 in Hattie Cove, Pukaskwa National Park. At that time the fish had the following measurements:

SL - 60
FL - 64
TL - 66
Weight: 1820 grams
Age A: 5++
Age B: 5++ (confidence rating of 7)

Bob Reside
Park Warden
17 February 1991

TABLE 7 FISH TAGGING HATTIE COVE - 1989 (cont.)

TAG#	DATE CAUGHT	SPECIES	SL	FL	TL	WT(g)	AGE A	AGE B
19	Oct 17/88	Pike	70.5	74.0	79.0	3320	7+	7+ (7)
20	Oct 17/88	Pike	79.5	83.5	88.5	5320	6++	6++(7)
21	Oct 17/88	Pike	73.5	77.5	81.5	3920	4++	4++(7)
22	Oct 17/88	Pike	73.5	78.0	82.5	3720	5++	5++(7)
23	unknown	Pike	60	64	66	1820	5++	5++(7)
24	Oct 18/88	Pike	81.0	86.0	90.0	5720	5+	5+ (7)
26	Oct 19/88	Pike	62.0	66.0	70.5	1900	5+	5+ (7)
28	Oct 19/88	Pike	50.5	54.5	57.5	1100	4+	4+ (5)
30	Oct 20/88	Pike	72.0	75.0	79.0	3420	No good scales	
31	Oct 21/88	Wh. Fish	42.0	44.5	49.5	unknown	10+	10+ (7)
33	Oct 21/88	N.Pike	31.0	33.0	35.5	unknown	1++	1++ (7)
42	Oct 26/88	N.Pike	29.0	31.0	33.0	180	0++	0++ (7)
44	Oct 27/88	Wh. Fish	47.0	50.0	50.0	1460	12+	12+ (7)

Tags destroyed - 3,8,25,27,29,34-41.

A - Assessed age = the number of complete annuli present and the time of capture.
B - Calcified structure age; the actual number of annuli showing plus the edge condition i.e. 3++ 3 annulis with lots of growth
* - annulus on edge
o - annulus assumed to exist with edge
()- confidence rating from 1 - 10.

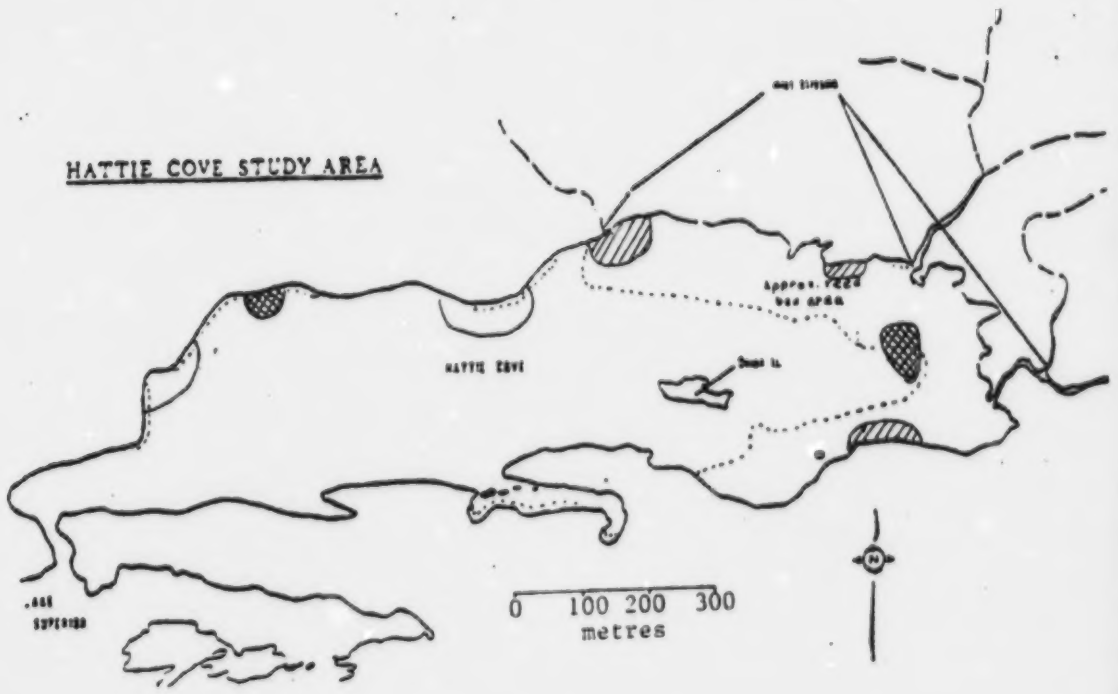
Harvested fish - tag #17

TABLE 8 FISH TAGGING - TELEMETRY, HATTIE COVE 1989

TAG#	DATE	SPECIES	SL	FL	TL	WT(g)	Age A	Age B
19R	Oct 21/89	Pike	69.0	74.0	77.0	-	8++	8++
26R	Oct 18/89	Pike	65.5	70.0	70.5	2400	6+	6+
45	Jun 6/89	Pike	46.5	50.5	53.5	-	4°	3+
48	Jun 6/89	Pike	58.0	59.5	60.9		6°	5+
49	Oct 18/89	Pike	52.0	55.50	58.0	1100	2++	2++
51	Oct 18/89	Pike	70.0	75.0	80.0	3500	4+	4+
53	Oct 21/89	Pike	59.5	64.0	67.5	2000	3++	3++
54	Oct 21/89	Pike	60.0	64.5	67.5	1800	4+	4+
56	Oct 22/89	Pike	68.0	76.0	77.0	3100	5+	5+
59	Oct 23/89	Pike	64.1	70.5	72.3	2600	5++	5++
61	Oct 23/89	Pike	55.5	61.5	63.0	1500	3++	3++
62	Oct 24/89	Pike	60.5	65.5	69.5	2500	8+	8+
63	Oct 24/89	Pike	47.0	51.0	53.0	0800	2+	2+
66	Oct 31/89	Pike	75.0	84.0	86.0	4400	7++	7++
67	Nov 2/89	Pike	56.0	60.5	63.5	1500	3++	3++
68	Nov 2/89	Pike	56.5	61.0	64.5	1900	5+	5+
69	Nov 2/89	Pike	57.0	61.0	64.5	1700	4+	4+
70	Nov 3/89	Pike	55.0	59.5	63.5	1300	4+	4+
71	Nov 3/89	Pike	66.5	72.0	76.0	2300	6+	6+
72	Nov 3/89	Pike	58.5	63.0	67.5	1700	6+	6+
73	Nov 3/89	Pike	49.0	53.5	56.5	0900	2+	2+
Transmitter								
285	Jun 6/89	Pike	-	-	66.5	-	5°	4+
348	Jun 6/89	Pike	-	-	64.5	-	5°	4++
357	Jun 6/89	Pike	-	-	73.7	-	5°	4++

A - Assessed age = the number of complete annuli present and the time of capture.
B - Calcified structure age; the actual number of annuli showing plus the edge condition i.e. 3++ 3 annulis with lots of growth
* - annulus on edge
° - annulus assumed to exist with edge
()- confidence rating from 1 - 10.

FIGURE 11 Success Location Sites for Capturing Pike



Pike Tagging October 18 - November 3, 1989

Pike Tagging October 6 - October 27, 1988

Pike Telemetry June 6 & 25, 1989

4.6 Ultrasonic Telemetry

4.6.1 Success of the Surgical Procedure

Table 9 is a summary of the survival status of each pike after the surgical procedure on June 6th and 20th, 1989.

TABLE 9 Status of Fish Survival After Surgical Implantation of Transmitters

Species	Total Length	Transmitter ID Code	Frequency	Surgery Date	Status	Survival Days
Pike	57.8	339	78 KHZ	06/06/89	assumed to have died around 28/06/89	22
Pike	50.8	249	75 KHZ	06/06/89	movement in and out of Hattie Cove 29/04/90	assumed to have survived
Pike	64.5	348	78 KHZ	06/06/89	assumed to have died on 11/07/89	35
Pike	73.7	357	78 KHZ	06/06/89	caught by fisherman in good condition	survived surgery but caught by fisherman 52 days
Pike	66.5	285	75 KHZ	20/06/89	unknown - left Hattie Cove 25/06/89	unknown

Pike 339 - This pike's signal had been heard in the same general area since June 15. It may have still been alive on June 24 when it was missing from the cove. However, since June 26, it appeared to have stayed in the same area. On June 27, a fish was seen swimming in the usual area of 339. This may have been the pike containing transmitter 339 and was assumed to have died within the next few days, floated to the surface, and then eaten by birds. The transmitter probably fell to the bottom, which is why it had not moved since. Attempts to locate transmitter have been unsuccessful. It was noted missing on August 4 and 7, 1989, however this finding was due to problems with batteries and earphones. It was later found in the same area.

Pike 249 - This pike was assumed to have survived the surgical procedure. On April 29, 1990, the signal was heard at the east shallow end of the cove. This was the day after the ice left the cove and was assumed that Pike 249 was probably spawning at the time. Its movement was recorded from day to day. There were times when the signal was not heard and it was assumed that Pike 249 left the cove for a few days at a time. The transmitter was heard in February, 1990 in the area of the main basin of the cove.

Pike 348 - This pike did not survive the surgical procedure on June 10, 1989. Summer staff had noted the red "vein-like" marks around the sutured area. It was found floating, "belly-up", but still alive. It was revived and let go. The next day its movement had stopped and was assumed dead. The cause was assumed to be through infection.

Pike 357 - This pike was caught by a fisherman on July 28, 1989. It had recovered completely from the surgical procedure. The suture line was not noticed and it was not until it was being cleaned that the transmitter in the abdominal cavity was observed.

Pike 285 - This pike was surgically implanted on June 20, 1989. The survival status of this pike was unavailable. It appeared to be moving around the east end of Hattie Cove during the first five days, after which its presence was undetectable with the receiver and was believed to have lef.

the cove. Because of the warmer water temperature and softer flesh during the surgical procedure, the likelihood of this pike's survival was much less than those implanted in early June.

4.6.2 Tracking Results

Table 10 is a summary of the movement of the pike which contained the surgically implanted transmitters.

Pike 339 - Until the day it was believed to have died, the transmitter signal was not received for two days of the possible 22 days. Of these 22 days, movement around the cove was noted for 7 days.

Pike 249 - This pike's signal was not received in the cove for 41 of the 63 days monitoring from the period June 7 - August 24. These were intermittent disappearances ranging from 1 day to 11 days and possibly extended to 21 days as there was a break of two days where monitoring was not carried out. It was assumed that the pike travelled in and out of the cove during the course of the monitoring season, remained in the area during the winter (Feb. 15/90), and was found at the east shallow end of the cove the day after the ice melt (April 29, 1990).

Pike 348 - This pike was monitored daily for 33 of the 35 days it was assumed to be alive. The results indicated that it was not found in the cove for 9 days. The days not found varied from the intermittent one day to two days.

Pike 357 - This pike exhibited movements in and out of the cove from June 6 until its capture on July 28, 1989. Of its 45 days of monitoring, it was recorded missing from the cove for 16 days. These intermittent periods ranged from one day to five days at a time.

Pike 285 - This pike was implanted with a transmitter on June 20, 1989. It was monitored for 50 days. Of these days, its signal was received for the first 5 days. Its signal was not present on October 26, 1989, February 15, and April 29, 1990. It is assumed that this pike left the cove.

TABLE 10 Summary of Movement of Pike in Hattie Cove

JUNE	339	249	348	357	285	REMARKS
7	M	M	M	0	N/A	
8	M	M	M	M	N/A	357 near small bay
9	M	M	M	M	N/A	
10	M	M	M	M	N/A	
11	0	M	M	M	N/A	
12	M	M	M	0	N/A	
13	0	M	M	M	N/A	
14	M	M	S	0	N/A	
15	S	M	0	M	N/A	
16	S	0	M	M	N/A	
17	S	M	M	S	N/A	
18	S	0	M	M	N/A	
19	S	0	S	0	N/A	
20	S	M	S	M	M	339 appeared to be moving in the same general area-during telemetry monitoring.
21	S	0	M	M	M	Pulpwood Harbour checked/no signal
22	S	0	0	0	M	
23	S	0	0	0	M	Checked Pulpwood in evening with no result
24	0	0	M	0	M	
25	M	0	0	M	0	Evening - checked mouth of Pic River to Horseshoe Beach, Playter and Pulpwood Harbours/no results
26	S	0	0	M	0	
27	S	0	M	M	0	Searched for 339 - saw one fish swimming away - 339 was assumed to have died within a few days
28	S	0	0	M	0	
29	S	0	M	M	0	
30	S	0	0	M	0	

M - Movement from previous day
S - Same location as previous day
O - Not found in cove
X - No telemetry monitoring
C - Caught

TABLE 10 Summary of Movement of Pike in Hattie Cove (cont.)

JULY	339	249	348	357	285	REMARKS
1	S	0	M	0	0	
2	X	X	X	X	X	
3	X	X	X	X	X	
4	S	0	0	M	0	Check Pulpwood Harbour/no results
5	S	0	M	0	0	
6	S	0	M	M	0	
7	S	0	S	0	0	339 in general area
8	0	0	0	0	0	
9	S	0	M	0	0	
10	S	0	M	0	0	348 found floating "belly-up" but still alive, it was revived and released. Searched for 339 with mask and snorkel with no results 348 was assumed to have died on this date
11	S	0	M	0	0	
12	S	M	S	M	0	
13	X	X	X	X	X	
14	S	0	S	M	0	339 & 348 appeared to have moved by reading maps - but probably in same area
15	S	X	S	M	0	
16	S	M	S	M	0	
17	S	0	S	M	0	
18	S	M	S	0	0	
19	X	X	X	X	X	
20	S	0	S	M	0	
21	S	M	S	M	0	
22	S	0	S	M	0	
23	S	0	S	0	0	
24	X	X	X	X	X	
25	X	X	X	X	X	
26	S	0	S	M	0	
27	S	M	S	M	0	
28	X	X	X	C	X	357 caught by a fisherman - incision had healed ok - transmitter returned
29	X	X	X	N/A	X	
30	X	X	X	N/A	X	
31	X	X	X	N/A	X	

M - Movement from previous day
S - Same location as previous day
O - Not found in cove
X - No telemetry monitoring
C - Caught

TABLE 10 Summary of Movement of Pike in Hattie Cove (cont.)

AUG	339	249	348	357	285	REMARKS
1	X	X	X	N/A	X	
2	S	M	S	N/A	0	
3	S	0	S	N/A	0	
4	0	0	S	N/A	0	
5	X	X	X	N/A	X	Dead battery on receiver
6	S	0	S	N/A	0	Battery changed-working again
7	0	0	0	N/A	0	No signals
8	S	0	S	N/A	0	
9	S	0	S	N/A	0	Partial telemetry search
10	S	0	S	N/A	0	Partial telemetry search
11	S	0	S	N/A	0	Partial telemetry search
12	S	0	S	N/A	0	
13	S	0	S	N/A	0	
14	S	M	S	N/A	0	
15	S	M	S	N/A	0	
16	S	M	S	N/A	0	
17	S	M	S	N/A	0	
18	X	X	X	N/A	X	
19	X	X	X	N/A	X	
20	S	0	S	N/A	0	Searched for transmitter 339 held hydro-phone in vertical position downward → sound from the general area
21	X	X	X	N/A	X	
22	X	X	X	N/A	X	
23	S	0	S	N/A	0	
24	S	M	S	N/A	0	
FEBRUARY						
15	S	M	S	N/A	0	
APRIL						
29	0	M	S	N/A	0	Shore search of Hattie Cove. 339 signal not picked up, as its usual location was blocked from the receiver.

M - Movement from previous day
S - Same location as previous day
O - Not found in cove
X - No telemetry monitoring
C - Caught

4.7 Creel Census

The creel census was separated into two seasons. The ice fishing creel dates were from January 14 to April 23, 1989 and November 19, 1989 to January 13, 1990. The rod and reel fishing creel dates were from June 24 to November 18, 1989. The creel census was not carried out for the period starting April 24 to June 23 due to ice melt conditions restricted fishermen from entering the cove, and also this pre-summer visitor season did not show signs of fishermen.

The calculations for the results and statistical test are listed in Appendix E. Table 11 summarizes the results for both seasons. It should be noted that although the ice creel was carried over two winter seasons, it represented the year 1989.

The 1989 ice fishing creel did not record fishermen from the period November 19, 1989 to January 13, 1990. The results were calculated for the previous winter season, January 14 to April 23, 1989.

4.8 Mercury Analysis

Table 12 lists the results of mercury (mg/kg) levels in pike caught in Hattie cove. The levels ranged from 0.13 mg/kg in a 47 centimetre pike to 0.58 mg/kg in a 59 centimetre pike. See discussion 5.8 for consumption guidelines.

5.0 DISCUSSION

5.1 General Inventory - Maps

All maps provide base line data for future reference.

5.2 Water Quality

During the October temperature readings, no thermocline was present. Hattie Cove may have already entered into "fall turnover" which was greatly influenced by the wave and current motion of Lake Superior. Upper Lakes Reference Group (1977) stated that near-shore areas of Lake Superior establish thermal stratification in mid or late June. Also, a "thermal curtain" separates the cold water from the warmer water near-shore areas from the time the ice melts to mid June. It has been determined that this curtain exists 7 kilometres off shore. This phenomena will be discussed further with the fish telemetry study.

The February temperatures of 0° and 1.0° were well below the 4° point where water reaches its density. The action of the current entering Hattie Cove probably

TABLE 11 1989 Creel Census Summary

	Ice Creel Census	Rod and Reel Creel Census
Fishing pressure: # of hours fished:	62.860	34.700
Total # of persons fishing per season:	100.000	60.000
Total # of groups fishing trips:	39.000	30.000
Total # of Pike caught:	20.000	7.000
Total # of fish caught:	110.000	7.000
Pike(x) mean catch per unit of effort per person:	.072	.118
Total fish (x) mean catch per unit of effort per person:	.790	.118

TABLE 12 HATTIE COVE TISSUE SAMPLES - MERCURY RESULTS

	MERCURY mg/kg		DATE	TL	FL	SL	WT	AGE A	AGE B
1.	.18	Pike	Jan.15, 1989	52.0	45.6	43.1	700 g	3°	2++
6.	.26	Pike	Jan.22, 1989	56.0	54.0	51.0	1000 g	4°	3++
8.	.20	Pike	Jan.27, 1989	53.0	50.0	46.0	700 g	3°	2++
10.	.58	Pike	Jan.27, 1989	59.0	55.0	51.0	1000 g	5°	4+
11.	.24	Pike	Jan.28, 1989	55.5	51.5	48.5	800 g	3°	2++
12.	.22	Pike	Jan.28, 1989	56.0	53.5	49.5	850 g	3°	2+
19.	.46	Pike	Mar.19, 1989	71.0	66.0	63.0	2200 g	7°	6++
26.	.41	Pike	Apr. 1, 1989	67.0	64.0	59.0	1700 g	6°	5++
30.	.13	Pike	Apr. 3, 1989	47.0	45.0	41.5	500 g	2°	1++
31.	.26	Pike	Oct.16, 1989	55.0	53.0	48.5	837 g	-	-

all accepted

Mercury analysis: date received Oct. 26, 1989
date last analyzed Dec. 05, 1989
exp. complete Dec. 21, 1989

A - Assessed age = the number of complete annuli present and the time of capture.
B - Calcified structure age; the actual number of annuli showing plus the edge condition i.e. 3++ 3 annulis with lots of growth
* - annulus on edge
° - annulus assumed to exist with edge
()- confidence rating from 1 - 10.

prevents the water from freezing through to the bottom, even though the temperatures were at 0° and 1° Celsius. Upper Lakes Reference Group (1977) contained limited information on temperature. However, it stated that the fall season had temperatures ranging from 4.8 to 11.2° Celsius which were lower in comparison to this study's October temperatures. Hattie Cove's lowest temperature was 11.5 at the bottom of the main basin (10 m) and at the entrance into Hattie cove. Although Hattie Cove is part of Lake Superior, its isolation and shallowness is able to keep the warmer tempertures for a longer period of time than other near-shore areas of Lake Superior.

The oxygen levels in Hattie Cove were above the 5 mg/l minimal levels for which fresh water fishes can survive in. Levels of 3 mg/l or lower are lethal to fish (Welch, 1952). In comparison to the 1973 near-shore oxygen levels of Lake Superior (Upper Lakes Reference Group, 1977), Hattie Cove was within that year's mean of 8 - 14 mg/l.

The lowest pH recorded was 7.51 at the bottom of the main basin in February, all other depths had higher readings during both February and October sampling dates. The highest pH recorded was 8.29 at the entrance to Hattie Cove in October. The acceptable pH range for fish is between 6.5 and 8.5, and 6.5 and 9.0 for aquatic life. (Cooperrider, Boyd and Stuart, 1986). The results were within these ranges and are therefore good indicators of a healthy environment for pike. The data for Lake Superior in 1973 (Upper Lakes Reference Group, 1977) reported a similar mean range of 7.5 to 8.5.

Station 5 had a reduction in specific conductivity from February (225) to October (176). This higher reading in February may have been the result of the ice auger mixing sediments at the depth 1.0 metre. The basin of Hattie Cove had an average decrease in specific conductivity from February to October of 29 micromhos/cm. No other changes in specific conductivity were noticed.

The mean secchi disc depths in the deeper areas of Hattie Cove were 3.5 in the main basin and 3.0 metres further east. This difference of 0.5 metres the result of the current moving the secchi disc away from the boat. The mean depth of 3.0 metres which was measured further toward the back of Hattie Cove is therefore more reliable. In comparison to 1973 results of near-shore Lake Superior (Upper Lakes Reference Group 1977) the mean annual secchi measurements ranged from 5.6 - 11.3 metres which is at least 2.6 metres deeper than Hattie Cove's mean depth of 3.0 metres. Upper Lakes Reference

Group also noted that embayments readings were at least 50% lower than near-shore readings. As with Hattie Cove, the lower secchi disc's measurements may be due to the resuspension of sediments caused by the current action.

5.3 Benthic Fauna

During the collection and hand picking of the benthos sweep samples, a visual glance of the results were in indicator of the low productivity of Hattie cove. The following discussion is based on the comparisons of the littoral zones (up to 1.0 metre) of Lake Simcoe, Ontario (Welch 1952, Rawson 1930) to those of Hattie Cove.

The Hattie Cove results for sandy areas were slightly lower with a difference of only 7 organisms per square metre. The areas containing vegetation, on the other hand, had remarkable differences in population per square metre. Lake Simcoe recorded 685 organisms in mud with vegetation. Hattie Cove had lower populations (average) of 321 (emergent plants), 228 (submergent plants), and 491 (nuphar beds). The bare scatter rocks on the south side of the cove were sampled with results of 113 organisms (average) per square metre which is half of the 227 of Lake Simcoe. All sweep samples were taken up to one metre depth along the littoral zones. Welch (1952) stated that bottom of lakes made up of gravel, sand or rocks often show the highest productivity. Hattie Cove does contain sand, along the north shore and day use area but is predominantly muck in the deep basin and the east end.

The Ekman$_2$ samples provided population averages of 152/.02 m^2 (area of Ekman$_2$ grab) at 9 metres; 53/.02 m^2 at 6 metres, and 92/.02 m^2 at 2.75 metres. In relation to benthic fauna population of Batchawana Bay (Dermott 1985), Hattie Cove's averages were lower by: 51 organisms/.02 m^2 at low depths; and 1.443 - 1482 organisms/.02 m^2 at depths greater than 3 metres. It appears that Hattie Cove's profundal zone has little productivity in relation to the southern waters of Lake Superior.

Hattie Cove is not considered productive for benthic fauna and should be monitored again at a later time to compare results.

5.4 Minnow Trapping

The results indicate the absence of a minnow population, however, minnows were caught in the large trap nets during the pike trapping for the telemetry study. It was interesting to note that each large trap net (Figure 9) only contained forty minnows (shiners) in comparison to the size of the traps. It appears that Hattie Cove contains a small minnow population. This is not surprising in relation to the low benthic fauna population per square metre. If the food sources are low, then it is reasonable to assume that the preying animal population would also be low.

The minnow trapping was carried out for two overnight sets of ten traps in August. In order to get a better idea of the type of minnow population, future studies should be carried out at different times during the summer, using a bait other than crackers and cat food. It should be clear that whatever bait is to be used, must be removed with the traps.

5.5 Fish Tagging

The amount of time spent on this capture/recapture study did not provide enough data to estimate a population.

It was assumed that pike enter and leave the Cove on a regular basis which was the main reason why there were only 17 pike tagged in 1988, and 19 in 1989. The locations where they were being trapped in 1988 and 1989 indicated that they probably move from the east end of Hattie Cove in early October, closer to the entrance area in late October and November. This is probably the time of year when most movement occurs. This movement will also be discussed in Section 5.6, Ultrasonic Telemetry.

5.6 Ultrasonic Telemetry

5.6.1 Surgical Implantation

Of the five pike which were surgically implanted with a transmitter, two (339 and 348) were presumed dead, two (249 and 357) survived (although 357 was caught by a fisherman), and the last pike's (285) status was unknown. The causes of the death of the two pike were probably infection, and/or trauma to the internal organs. It was believed that pike 348 died of an infection. It was also believed that because of the later date of pike 285's surgical implantation, its survival chances were lessened as compared to those done in early June. It was

noticed that the tissue had softened, making suturing difficult. The edges of the surgical cut were not approximate during the suturing, therefore the risk of infection was present. However, its death/survival was unknown due to the fact that the transmitter signal was lost in Hattie Cove and not received out of the cove.

This procedure had lost at least two of the five pike (40% mortality). However, the data obtained by the study provided valuable information about pike movement in Hattie Cove.

5.6.2 Tracking

It was believed that pike were permanent residents of Hattie Cove due to a "thermal blanket" existing at the entrance of the Cove. This "thermal blanket" was believed to be too cold for pike to wander out into deep Lake Superior waters. The purpose of this study was to find out if this residency theory existed.

Scott and Crossman (1973) state that pike are sedentary, establish a vague territory in adequate fod and cover, and have been known to move extensively during the spawning season, and in the fall.

According to the results, the pikes' signals were not found in Hattie Cove on different occasions from June to August 24, 1989, and on February 15 and April 29, 1990. It was believed that pike did in fact move out of the cove for brief periods of a few days at the least. It was assumed that one pike (249) stayed in the cove all winter, but another (285) had left the cove after the fifth day and was not heard of since.

Pike in Hattie Cove may not be permanent residents, but residents of the general area. Reasons for this include: a thermal barrier which exists about 7 kilometres off shore of Lake Superior (Upper Lakes Reference Group 1977) may be preventing pike from wandering too far; and the weed bed at the east end of the cove is massive in relation to the other spawning beds in the area (White River), which pike migrate to in order to spawn immediately after ice melt.

5.7 Creel Census

The Creel Census was divided into two separate sampling censuses. During the Ice Census (i) 298 samples were taken. During the Rod Census (r) 232 samples were taken. Each sample represents one fishing trip. General observations indicate that because the sample size was very large (one year in duration) the fishing pressure was accurately determined.

A statistical test was used to verify this assumption. The test employed the use of the sample size standard deviation in order to determine the confidence interval. The confidence gives an indication of the precision at which fishing pressure was sampled.

The confidence interval for the Ice Census was calculated to be approximately 99%. The confidence interval for the Rod Census was calculated to be 85 - 90%. Both confidence intervals indicate that fishing pressure was sampled with good precision. Therefore it is agreed that the sample size was large enough in both censuses to give an accurate indication of fishing pressure. See Appendix E for the results.

The 1989 creel summary stated that the (mean) catch effort per hour per person for pike was 0.072 for ice fishing and 0.118 for rod and reel fishing. Scott and Crossman (1973) state that the average angler success for pike is 1.8 to 2.2 fish per hour. Hattie Cove's results for ice fishing were considerably lower, even though most ice fishermen have up to two lines each, which doubles their effort. This doubled effort still gave lower success than the single rod fishermen during the rod and reel creel census of 0.113 pike per hour.

During the winter creel census, the other species caught was perch which increased the mean catch effort to 0.790 which was also considerably low.

The rod and reel catch per unit of effort per person for pike was 0.118, which was the only species recorded during the summer. This catch per unit of effort was also well below the average 1.8 to 2.2 pike for good fishing results. The stratified rod creel census was not scheduled for evening fishermen, therefore there was the possibility that the evening anglers were missed.

There were no random creel census recorded after the 1700 hours for the rod and reel fishing season.

The following factors may have affeted the creel census results:

- group effort is not as accurate a individual effort

- rod creel (during the summer) did not include evening stratified census therefore anglers may have been missed. Although random creel census was carried out to interview such times, it was not surveyed unless there was a warden working and noticed the angler by chance.

- students were carrying out creel interviews and there were times when they were unable to get a canoe onto Hattie Cove to conduct the interviews. This information was therefore lost.

However, it was believed that the information received to complete Table 11, was an accurate estimate of fishing pressure; total number of persons fishing per season; total number of groups fishing trips; total number of pike caught; total number of fish caught; the mean catch of pike per person per hour; and the mean total catch per person per hour.

5.8 Mercury Analysis

Consumption guidelines for Sport Fishing in Pukaskwa National Park place no restrictions on fish consumption for mercury levels less than 0.5 ppm (mg/kg). The mercury content of 0.58 mg/kg exceeded this limit in one larger pike of 59 centimetres. This indicated that weekly consumption guidelines should be in effect for pike of at least 55 centimetres in length. The present WARNING notice does not include pike from Hattie Cove. Apart from the lakes listed in the WARNING notice, safe pike consumption may be assumed in other Park lakes in fish less than 45 centimetres. However, Hattie Cove is not an inland lake but part of Lake Superior. The WARNING notice should include updated consumption guidelines for pike in Hattie Cove.

6.0 CONCLUSION

The acquatic resources inventory provided baseline data for future monitoring of the resources in relation to pike habitat. Hattie Cove contained low productivity in benthic fauna and minnows and a small population of pike. The study indicated that perch were common during the winter, and white sucker and white fish common during the summer season (gill netting, trap setting and visual observation). Other species of fish observed include rainbow trout and muskellunge. The

telemetry study did not prove that pike migrated in and out of the cove, but was assumed that pike did temporarily migrate.

Fishing pressure was low and so was the catch per unit of effort during both winter and summer seasons.

Future management decisions for the pike fisherie in Hattie Cove will be based on the findings of this study, and those of the recommended future monitoring studies.

7.0 RECOMMENDATIONS

The Sport Fish Management Plan Pukaskwa National Park (Schiefer et. al. 1986) stated the need to monitor areas of high priority (ie. unique fish population, and a fishing pressure) every three to five years. Hattie Cove was considered to be an area of higher priority, therefore, monitoring should occur by 1994.

In addition to the aquatic resources monitoring, the following items should be considered.

1. Benthic fauna - due to the low productivity results of this inventory, future sampling should be carried out to compare any changes in population. The amount of time needed to collect and process the samples would limit this survey to a 5 year interval.

2. Minnow trapping - in order to fully understand the ecosystem of Hattie Cove, future trapping should be carried out to identify minnow species and their abundance. This should be accomplished in order to decide on the type of fisheries management/regulations needed for the Cove.

3. Fish tagging and ultrasonic telemetry - due to the amount of manpower needed to monitor the tagging and telemetry, these activities should be carried out only if the need arises to positively identify pike as migrant or permanent residents of the Cove. It is not necessary to use anesthesia as pike were found to be quiet when on their backs.

4. Creel census - creel census should be continued for the summer of 1990. Recommendations as to the continuation of this activity beyond 1990 will be recommended in the report for 1990. Future data collections should include the following:

A) Winter: Total creel count

1. carry out stratified creel twice daily, but attempt to count all fishermen, if possible

2. carry out personal interviews as opposed to group interviews as in this report

3. surveyor may not necessarily stay for the 1/2 hour because of the time it takes to set up in Hattie Cove and the distance from the barricade to the ice.

B) Rod creel

1. carry out stratified creel 3 times daily for 1/2 hour and make sure surveyor stays there for the 1/2 hour.

2. the day be stratified into 3 blocks :
   0700 - 1200
   1200 - 1700
   1700 - 2200
   in order to get those evening fishermen efforts as well.

3. continue with random creel to obtain more data.

C) New creel census questions could be aimed determine the level of experience anglers have which could give a better interpretation of the number of fish per unit of effort. The type of fisherman has an effect on whether fish have the potential of getting caught. There are those anglers who know how to catch pike and those who are fishing in order to enjoy the outdoors with no special techniques used.

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APPENDIX A

Hattie Cove Benthos Samples: Field and Lab Summary

Terms of Reference for Benthos Sample Identification

Benthos Sample Identification for Hattie Cove, Pukaskwa National Park, 1989

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HATTIE COVE BENTHOS SAMPLES

AUGUST/89

D.O. DORIS ODJICK W.M. WAYNE MICHA
D.M. DANIEL MICHANO D.J. DAVE JIVCOF

SITE	SAMPLE	SAMPLING DATE	SAMPLING DEVICE	DEPTH OF WATER	DATE PICKED	LIVE	PRESERVED	PICKED BY	SUBSTRATE
1	Rep 1	09/08/89		35 cm	06/10/89	no	10/08/89	D.O.	sand
1	Rep 2	09/08/89	Kick & Sweep (0.5 m2)	35 cm	09/08/89	yes	09/08/89	M.S.	sand
1	Rep 3	09/08/89		35 cm	06/10/89	no	10/08/89	W.M.	sand
2	Rep 1	09/08/89		57 cm	10/10/89	no	10/08/89	D.O.	emergent veg rus
2	Rep 2	09/08/89		57 cm	15/10/89	no	10/08/89	D.O.	emergent veg rus
2	Rep 3	09/08/89		57 cm	14/10/89	no	10/08/89	D.O.,D.J.	emergent veg rus
3	Rep 1	09/08/89	Kick & Sweep (0.5 m2)	80 cm	09/08/89	yes	09/08/89	M.S.	submergent ve
3	Rep 2	09/08/89		80 cm	06/10/89	no	10/08/89	D.O.,W.M.	submergent ve
3	Rep 3	09/08/89		80 cm	10/10/89	no	10/08/89	D.O.	submergent ve
4	Rep 1	09/08/89		78 cm	30/10/89	no	10/08/89	D.O.	nuphar, lily pa
4	Rep 2	09/08/89	Kick & Sweep (0.5 m2)	78 cm	09/08/89	yes	09/08/89	M.S.,G.F.	muck, lily pad
4	Rep 3	09/08/89		78 cm	20/10/89	no	10/08/89	D.O.	nuphar
5	Rep 1	09/08/89		92 cm	11/10/89	no	10/08/89	D.O.,D.J.	rock
5	Rep 2	09/08/89		92 cm	06/10/89	no	10/08/89	D.O.,W.M.	rock
5	Rep 3	09/08/89		92 cm	16/10/89	no	10/08/89	D.O.	rock
1	Rep 1	10/08/89	EKMAN	9.5 m	28/11/89	no	11/08/89	D.O.	
1	Rep 2	10/08/89	EKMAN	9.0 m	10/08/89	yes	10/08/89	M.S.	
1	Rep 3	10/08/89	EKMAN	9.25 m	29/11/89	no	11/08/89	D.O.	
2	Rep 1	10/08/89	EKMAN	6.5 m	10/08/89	yes	10/08/89	G.F.	
2	Rep 2	10/08/89	EKMAN	6.5 m	03/12/89	no	11/08/89	D.O.,D.J.	
2	Rep 3	10/08/89	EKMAN	5.5 m	02/12/89	no	11/08/89	D.O.	
3	Rep 1	10/08/89	EKMAN	2.75 m	10/08/89	yes	10/08/89	D.M.	
3	Rep 2	10/08/89	EKMAN	2.75 m	29/11/89	no	11/08/89	D.O.	
3	Rep 3	10/08/89	EKMAN	2.75 m	02/12/89	no	11/08/89	D.O.,D.J.	

HATTIE COVE BENTHOS SAMPLES

D.O. DORIS ODJICK W.M. WAYNE MICHAND M.S. MARGO SHAW
D.M. DANIEL MICHAND D.J. DAVE JIVCOFF G.F. GLENN FORWARD

G	DEPTH OF WATER	DATE PICKED	LIVE	PRESERVED	PICKED BY	SUBSTRATE	NOTES	
	35 cm	06/10/89	no	10/08/89	D.O.	sand		10% Formalin
	35 cm	09/08/89	yes	09/08/89	M.S.	sand		10% Formalin
	35 cm	06/10/89	no	10/08/89	W.M.	sand		10% Formalin
	57 cm	10/10/89	no	10/08/89	D.O.	emergent veg rushes		10% Formalin
	57 cm	15/10/89	no	10/08/89	D.O.	emergent veg rushes		10% Formalin
	57 cm	14/10/89	no	10/08/89	D.O., D.J.	emergent veg rushes		10% Formalin
	80 cm	09/08/89	yes	09/08/89	M.S.	submergent veg		10% Formalin
	80 cm	06/10/89	no	10/08/89	D.O., W.M.	submergent veg		10% Formalin
	80 cm	10/10/89	no	10/08/89	D.O.	submergent veg		10% Formalin
	78 cm	30/10/89	no	10/08/89	D.O.	nuphar, lily pads		10% Formalin
	78 cm	09/08/89	yes	09/08/89	M.S., G.F.	muck, lily pads	SWof Island	10% Formalin
	78 cm	20/10/89	no	10/08/89	D.O.	nuphar	2 bottles (one with snail)	10% Formalin
	92 cm	11/10/89	no	10/08/89	D.O., D.J.	rock		10% Formalin
	92 cm	06/10/89	no	10/08/89	D.O., W.M.	rock		10% Formalin
	92 cm	16/10/89	no	10/08/89	D.O.	rock		10% Formalin
	9.5 m	28/11/89	no	11/08/89	D.O.			10% Formalin
	9.0 m	10/08/89	yes	10/08/89	M.S.			10% Formalin
	9.25 m	29/11/89	no	11/08/89	D.O.			10% Formalin
	6.5 m	10/08/89	yes	10/08/89	G.F.			10% Formalin
	6.5 m	03/12/89	no	11/08/89	D.O., D.J.			10% Formalin
	5.5 m	02/12/89	no	11/08/89	D.O.			10% Formalin
	2.75 m	10/08/89	yes	10/08/89	D.M.			10% Formalin
	2.75 m	29/11/89	no	11/08/89	D.O.			10% Formalin
	2.75 m	02/12/89	no	11/08/89	D.O., D.J.		worms in muscle	10% Formalin

TERMS OF REFERENCE
FOR
BENTHOS SAMPLE IDENTIFICATION
HATTIE COVE
PUKASKWA NATIONAL PARK
1989

BACKGROUND:

Benthos samples have been obtained from Hattie Cove, on Lake Superior, in Pukaskwa National Park as part of a study conducted foe the following purposes:

1. to establish baseline aquatic data for Hattie Cove
2. to assess the population status and habitat of Northern Pike within the cove.

STATEMENT OF WORK:

1) An estimated: 10 6"x 9" tall Ekman dredge samples, and 15 0.5 m^2 shoreline sweep samples will be provided.

2) Invertebrates are to be processed as follows:
For Ekman samples: Identification is to be done to species for adults, and to genus or subgenus (where possible) for immature specimens with the aid of published keys. A list of suggested references is available on request. List of references used are to be supplied upon completion of the contract. Chironomids and Oligochaetes are to be sorted into like groups (subfamilies for chironomids, hair chaetae present/absent for oligochaetes) and a representative number are to be mounted for identification. Twenty-five percent of individuals should be mounted to a maximum of fifty per samples.

For sweep samples: organisms are to be identified to family except for the Nematoda, Turbellaria, Hydracarina, and Ostracoda, which will not be identified any further. The Chironomidae will be identified to the subfamily level: Tanypodinae, Orthocladiinae,and the tribes Chironomini and Tanytarsini. For each replicate sample, the organisms in each of the identified taxa (or family) are to be enumerated. The total wet weight is to be estimated for each of the taxa found. Wet weights should be measured to the nearest 1.0 mg after blotting of the excess water. Where the size and number of animals in a given taxa is small, the weight for that group may be recorded as less than 1 mg. A report shall be submitted , listing the numbers of animals and wet weights for each taxa present in each replicate sample, along with average and standard deviations for each sample site during each sample date.

3) A reference collection is to be made for the Ekman samples and the 0.5 m^2 samples. Chironomids and oligochaetes are to be

mounted; all others are to be preserved in separate labelled vials containing a few individuals for each species.

4) All samples are to be returned to Pukaskwa National Park upon completion of the contract.

BENTHOS SAMPLE IDENTIFICATION
for HATTIE COVE
PUKASKWA NATIONAL PARK, 1989

for:

Canadian Parks Service
Pukaskwa National Park
Hwy. 627 Hattie Cove
Heron Bay,Ontario

Prepared by:

William B. Morton
50 Montana Road
Guelph, Ontario
N1E 3M2

January 31,1990

Background:

Benthos samples were obtained from Hattie Cove, on Lake Superior, in Pukaskwa National Park, as part of a study conducted for the following purposes:

1. To establish baseline aquatic data for Hattie Cove
2. To assess the population status and habitat of northern pike within the cove.

Objectives:

This report outlines the procedures used to analyse the Hattie Cove benthos samples and compiles these results for future study.

Methods:

A total of 24 samples, 9 Ekman dredge samples and 15 0.5 sq.m. shoreline sweep samples, were analysed for this study.

The specimens of each replicate sample were placed into a glass petri dish and sorted to order,or higher taxonomic level , subsequent to final analysis. Sorting was done with the assistance of a dissecting microscope at low power (10x).

Invertebrates were processed as follows:

Ekman samples: All specimens were identified to species were possible (see Appendix III for taxonomic references). Chironomids were sorted into like groups and representatives of each slide mounted for identification. All Oligochaetes, up to a maximum of 50 per sample, were also slide mounted. Specimens of Acarina, Cladocera, Cyclopoids, etc., may also have been slide mounted if nescessary for their subsequent identification. Canada Balsam was used as the mountant in all cases. Dr. Gerry L. Mackie, University of Guelph, identified or confirmed all Molluscs from these samples.

Sweep Samples: Organisms were identified to family (subfamily and tribe for Chironomidae), except for Nematoda, Turbellaria, Acarina, Ostracoda, Cladocera and Copepoda, which were not identified further. For each replicate, the organisms in each taxa were enumerated and blot dry wet weights calculated to the nearest 0.1 mg. Taxa with small size and numbers may have had their weights recorded as less than 1 mg.

A reference collection containing specimens of each taxon identified was compiled. Taxa found in the sweep samples , but not the Ekmans, were also included for completeness. This should increase the future usefullness of the collection.

Once processed all specimens were stored in labelled ½ dram polyshell vial, with rubber stoppers, and preserved in 75 % ethanol. Specimens from each replicate not included in the reference were grouped as Crustacea, Mollusca, Chironomids, and Miscellaneous taxa (if the numbers were small), to conserve storeage space.

All samples and data were returned to Pukaskwa National Park upon completion of the work.

Results and Discussion:

The identifications for the Ekman grab samples and the identifications with wet wieghts for the 0.5 sq.m. sweep samples are recorded in Appendices I and II respectively. There were 50 taxa recorded in the Ekman samples and 57 taxa (43 at the family level only) from the sweep samples. In total, 80 taxa were recorded from the samples (see Table 1).

The Ekman samples were characterized by chironomids, predominantly Micropsectra, Oligochaeta with Tubificids, and to some extent Diaporeia and Sphaeriidae. The sweep samples on the other hand were best characterized by the amphipods, Hyalella and Gammarus, Lirceus linaeta (Isopoda), Sididae (Cladocera), gastropods and a variety of shallow water insecta (Ephemeroptera, Hemiptera, Trichoptera). They also had

Table 1: Benthos Species List for Hattie Cove Samples, 1983

Annelida

Hirudinea
- Glossiphonia complanata S[1]
- Helobdella stagnalis

Oligochaeta[2]
Naididae
- Arcteonais lomondi
- Uphidonais serpentina

Tubificidae
- Aulodrilus americanus
- Limnodrilus clarapedianus
- Limnodrilus hoffmeisteri
- immatures with hairs
- immatures without hairs(Limnodrilus)

Acarina
- Arrenurus E
- Hydrachna S
- Hygrobates S
- Limnesia E
- Piona coccinea gp. E
- Unionicola

Crustacea

Amphipoda
Hyalellidae
- Hyalella azteca

Gammaridae
- Gammarus fasciatus

Pontoporeiidae
- Diaporeia (= Pontoporeia) spp.

Cladocera
Chydoridae
- Eurycercus S

Daphnidae
- Simocephalus S

Macrothricidae
- Ilyocryptus acutifrons

Sididae
- Latona setifera
- Sida crystallina S

Cyclopoida[2]
- Acanthocyclops vernalis
- Macrocyclops albidus

Isopoda
Asellidae
- Caecidotea(= Asellus) racovitzai
- Lirceus lineatus S

Ostracoda[2]
- Candona elliptica
- Cytherissa lacustris

Insecta

Coleoptera
Chrysomelidae
- Pyrrhalta nymphaea S

Dytiscidae
- Deronectes depressus-elegans S
- Hydroporus

Gyrinidae
- Gyrinus

Diptera
Ceratopogonidae
Chironomidae[2]
Chironomini
- Chironomus spp.
- Chironomus anthracinus/thummi gp.
- Dicrotendipes
- Pagastiella ostansa
- Paracladopelma galaptera
- Polypedilum halterales
- Polypedilum illinoense
- Polypedilum nebulosum
- Pseudochironomus

Tanytarsini
- Micropsectra
- Stempellinella(pupae)
- Tanytarsus

Diamesinae E
- Protanypus

Orthocladiinae
- Heterotrissocladius marcidus
- Parakiefferiella (pupae)

Tanypodinae
- Procladius

Tabanidae
- Chrysops S

Ephemeroptera
Baetidae/Siphlonuridae
Caenidae:Caenis S
Ephemeridae:Hexagenia
Heptegeniidae S
Leptophlebiidae S

Table 1: Benthos Species List for Hattie Cove Samples, 1989 (cont'd)

Hemiptera:	
Corixidae	
Palmacorixa buenoi	S
Sigara spp.	S
Sigara lineata	S
Sigara mullettensis	S
Notonectidae	
Notonecta (nymph)	S
Lepidoptera:Pyralidae	S
Odonata:	
Coenagrionidae	S
Trichoptera:	
Lepidostomatidae	
Lepidostoma	S
Leptoceridae	E/S
Nectopsyche	S
Oecetis	S
Phryganeidae	S
Polycentropodidae	
Phylocentropus	
Polycentropus	S
Bryozoa	
Plumatellidae	
Hyalinella poss. *punctata*	S
Coelenterata:Hydridae	S
Mollusca	
Gastropoda:	
Lymnaeidae	
Lymnaea stagnalis	S
Hydrobiidae	
Amnicola limosa	
Physidae	
Physella gyrina	S
Planorbidae	
Planorbella (Juveniles)?	S
Helisoma anceps	S
Valvatidae	
Valvata sincera	
Valvata tricarinata	S
Pelecypoda:	
Sphaeriidae	
Musculium transversum	
Pisidium casertanum	
Pisidium lilljeborgi	
Pisidium nitidum	
Nematoda:	E
Platyhelminthes:	
Planariidae	
'microturbellarians'	S

1 - E indicates found in Ekman samples only, S in sweeps only, all others were found in both types unless indicated otherwise.

2 - Oligochaeta, Cyclopoida, Ostracoda, and Chironomidae are recorded only for the Ekman samples since they were not id. to species for sweeps

chironomids and oligochaetes but in low numbers and [illegible] was almost non-existant. The sweep samples appeared more diverse with 33 unique taxa (Oligochaeta, Cyclopoida, Chironomidae excluded). This situation is not unexpected considering the sweep samples covered more diverse habitats than the Ekmans. It also points out the need for the sampling methods, habitat, and substrates, to be as much alike as possible before comparisons between samples can be made with confidence. These aspects should be considered if future study is to be done at these same sites.

Appendix I: Hattie Cove Ekman Grab Samples, 1989,
Invertebrate Identifications.

Re: Hattie Cove, Ekman Grab Samples, 1989, Invertebrate Identifications

REPLICATE →	S1R1	S1R2	S1R3
		9m.	9.25m
DATE →	89.08.10	89.08.10	89.08.10
TAXA			
ANNELIDA: OLIGOCHAETA			
NAIDIDAE			
Arcteonais lomondi	–	1	–
Ophidonais serpentina	–	1	–
TUBIFICIDAE			
Limnodrilus hoffmeisteri	1	–	–
Immatures without hairs	16	–	2
Immatures with hairs	4	4	5
ACARINA:			
PIONIDAE: Piona coccinea gp	1	–	–
UNIONICOLIDAE: Unionicola	–	–	1
CRUSTACEA:			
AMPHIPODA:			
GAMMARIDAE: Gammarus fasciatus	1	1	–
PONTOPOREIIDAE: Diaporeia (=Pontoporeia)	–	6	10
CLADOCERA:			
MACROTHRICIDAE: Ilyocryptus acutifrons	3	–	1
SIDIDAE: Latona setifera	1	–	–
CYCLOPOIDA:			
CYCLOPIDAE: Macrocyclops albidus	1	–	1
OSTRACODA:			
CANDONIDAE: Candona elliptica	1	–	1
CYTHERIDEIDAE: Cytherissa lacustris	–	–	2
INSECTA:			
DIPTERA:			
CERATOPOGONIDAE	1	–	–
CHIRONOMIDAE:			
CHIRONOMINI: Chironomus anthracinus/thummi gp	3	–	1
Paracladopelma galaptera	1	–	–
Polypedilum halterale	4	–	–
P. " illinoense	6	4	12
TANYTARSINI: Micropsectra	108	84	113
Tanytarsus	5	2	4
DIAMESINAE: Protanypus	1	–	–
ORTHOCLADIINAE: Heterotrissocladius marcidus	1	–	2
TANYPODINAE: Procladius	3	1	2
TRICHOPTERA:			
POLYCENTROPODIDAE: Phylocentropus (Nyce)	–	–	1
MOLLUSCA			
VALVATIDAE: Valvata sincera	1	–	–
SPHAERIIDAE:	15	3	17
Pisidium casertanum	15	2	12
P. " ultyeberi	–	1	–
NEMATODA	1	–	–

Re: Hattie Cove Ekman Grab Samples, 1989, invertebrate identifications.

TAXA	REPLICATE →	S2R1	S2R2	S2R3
	DATE →	89.08.10	89.08.10	89.08.10
ANNELIDA: HIRUDINEA:				
GLOSSIPHONIIDAE: Helobdella stagnalis		1	—	—
ANNELIDA: OLIGOCHAETA:				
NAIDIDAE: Arcteonais lomondi		3	5	1
TUBIFICIDAE: Limnodrilus claparedianus		1	—	—
" L. " hoffmeisteri		—	1	1
Immatures without hairs (Limnodrilus)-			1	—
CRUSTACEA:				
AMPHIPODA:				
GAMMARIDAE: Gammarus fasciatus		—	1	—
PONTOPOREIDAE: Diaporeia (= Pontoporeia)		3	12	2
CLADOCERA:				
MICROTHRICIDAE: Ilyocryptus acutifrons		—	3	1
SIDIDAE: Latona setifera		—	1	1
CYCLOPOIDA:				
CYCLOPIDAE: Acanthocyclops vernalis		—	3	1
Macrocyclops albidus		—	1	—
OSTRACODA				
CYTHERIDEIDAE: Cytherissa lacustris		—	1	—
INSECTA:				
DIPTERA:				
CHIRONOMIDAE:				
CHIRONOMINI: Chironomus spp (early instar)		—	1	—
C. " anthracinus/thummi gp-		1	—	—
Pagastiella ostansa		—	1	—
Polypedilum illinoense		1	—	—
TANYTARSINI: Micropsectra		18	35	32
Stempellinella (Pupae)		—	3	—
Tanytarsus		2	4	2
DIAMESINAE: Protanypus		1	1	1
ORTHOCLADIINAE: Heterotrissocladius marcidus		1	—	—
Parakiefferiella (Pupae)		—	2	—
TANYPODINAE: Procladius		—	1	—
MOLLUSCA:				
SPHAERIIDAE:		2	4	1
Pisidium casertanum		1	4	1
P. " liljeborgi		1	—	—
NEMATODA:		—	—	1

Re: Hattie Cove, Ekman Grab sample, 1984, Invertebrate [illegible]

REPLICATE →	S3R1	S3R2	S3R3
DATE →	89.08.10	89.08.10	89.08.10
TAXA			
ANNELIDA: OLIGOCHAETA:			
NAIDIDAE: Arcteonais lomondi	2	–	–
TUBIFICIDAE: Aulodrilus americanus	–	6	–
Immatures with hairs	–	–	2
ACARINA:			
ARRENURIDAE: Arrenurus	1	–	–
LIMNESIIDAE: Limnesia	1	1	–
UNIONICOLIDAE: Unionicola	–	1	–
CRUSTACEA:			
AMPHIPODA:			
GAMMARIDAE: Gammarus fasciatus	–	1	–
HYALELLIDAE: Hyalella azteca	7	6	4
PONTOPOREIIDAE: Diaporeia (=Pontoporeia)	8	3	23
ISOPODA:			
ASELLIDAE: Caecidotea (=Asellus) racovitzai	5	2	7
INSECTA:			
COLEOPTERA:			
DYTISCIDAE: Hydroporus (LARVAE)	1	–	–
GYRINIDAE: Gyrinus (LARVAE)	–	–	1
DIPTERA:			
CERATOPOGONIDAE	1	2	1
CHIRONOMIDAE:			
CHIRONOMINI: Dicrotendipes	2	–	–
Pagastiella ostansa	–	1	–
Polypedilum nub. nebulosum	7	15	3
Pseudochironomus	7	52	24
TANYTARSINI: Tanytarsus	–	1	1
↱ ORTHOCLADIINAE: Heterotrissocladius marcidus	–	1	1
↳ DIAMESINAE: Protanypus	–	1	3
TANYPODINAE: Procladius	3	13	4
EPHEMEROPTERA:			
EPHEMERIDAE: Hexagenia	1	–	1
MOLLUSCA:			
HYDROBIIDAE: Amnicola limosa	1	4	4
VALVATIDAE: Valvata sincera	–	2	–
SPHAERIIDAE:	4	17	10
Musculium transversum	2	2	1
Pisidium casertanum	2	13	5
P. " lilljeborgi f. cristatum	–	–	1
P. " nitidum	–	2	3
NEMATODA	2	3	1
PLATYHELMINTHES: PLANARIIDAE	–	1	–

Appendix II: Hattie Cove 0.5 square meter sweep samples, 1989
Identifications and Wet Weights.

Re: Hattie Cove, 0.5 m² sweeps, 1987, identifications mine, way...

REPLICATE →	S1R1 SAND	S1R2	S1R3 SAND
DATE →	89.08.09	89.08.09	89.08.09
TAXA			
ANNELIDA: OLIGOCHAETA			
NAIDIDAE	3, <1 mg	5, <1 mg	—
ACARINA	—	1, 0.7	—
CRUSTACEA:			
AMPHIPODA			
Hyalella azteca	—	—	1, <1 mg
Diaporeia (=Pontoporeia)	—	—	1, 0.6
CLADOCERA: SIDIDAE	3, <1 mg	—	4, <1 mg
CYCLOPOIDA	2, <1 mg	—	—
ISOPODA: ASELLIDAE			
Caecidotea racovitzai	—	—	1, 0.5
INSECTA:			
DIPTERA			
CHIRONOMIDAE:			
CHIRONOMINI	5, 2.0	2, <1 mg	2, <1 mg
EPHEMEROPTERA:			
BAETIDAE/SIPHLONURIDAE	—	—	1, <1 mg
HEMIPTERA:			
CORIXIDAE	—	1, 1.7	2, 1.6
TRICHOPTERA:			
LEPTOCERIDAE	—	—	1, <1 mg
MOLLUSCA: GASTROPODA			
HYDROBIIDAE: Amnicola limosa	3, 8.7	—	2, 2.3
LYMNAEIDAE: Lymnaea stagnalis	4, 4.9	—	—
PLANORBIDAE:	1, <1 mg	—	—
VALVATIDAE: Valvata tricarinata	—	—	1, 6.5.
: PELECYPODA			
SPHAERIIDAE	4, <1 mg	1, <1 mg	3, 2.4
TOTALS	25, 15.6 mg	10, 2.4 mg	19, 13.9 mg

$\bar{x} = 18$, stand. dev. = ; wt $\bar{x} = 10.6$ mg stan. dev.

Re: Hattie Love, U.S. [illegible]

REPLICATE →	S2 R1	S2 R2 EMERG. Veg.	S2 R3 Emerg. Veg.
DATE →	89.08.09	89.08.09	89.08.09
TAXA			
ANNELIDA: OLIGOCHAETA (TOTAL	3, 4.1	—	4, 2.2
NAIDIDAE	2		3
TUBIFICIDAE	—		1
CRUSTACEA:			
AMPHIPODA:			
Gammarus fasciatus	7, 1.8	11, 17.0	11, 34.4
Hyalella azteca	49, 30.9	64, 63.3	32, 29.2
CLADOCERA: SIDIDAE	48, 7.2	86, 20.1	71, 14.3
ISOPODA: Asellidae;			
Caecidotea racovitzai	7, 9.3	13, 18.3	11, 10.8
INSECTA:			
COLEOPTERA:			
DYTISCIDAE	1, 4 ms	1, 11.9	—
GYRINIDAE	2, 1.7	—	—
DIPTERA:			
CERATOPOGONIDAE:	1, 4 ms	—	6, 11.5
CHIRONOMIDAE (TOTAL)	6, 5.2	3, 4	4, 3.4
CHIRONOMINI	2, 5.2	1, 4	3, 2.4
TANYTARSINI	2, 4	1, <1	1, 4
ORTHOCLADIINAE	—	1, <1	—
TANYPODINAE	1, 4	—	—
EPHEMEROPTERA:			
BAETIDAE/SIPHLONURIDAE	1, 4	1, 4	4, 1.0
CAENIDAE: Caenis	—	1, 1.5	—
HEMIPTERA: CORIXIDAE	4, 1.8	2, 1.4	1, 1.2
ODONATA: COENAGRIONIDAE	—	2, 4	1, 4
TRICHOPTERA:			
LEPTOCERIDAE	—	2, 4	—
PHRYGANEIDAE	1, 2.1	2, 0.4	—
MOLLUSCA			
HYDROBIIDAE: Amnicola limosa	—	1, 16.5	1, 16.0
PLANORBIDAE: Planorbella	—	—	4, 4.0
VALVATIDAE: Valvata tricarinata	3, 14.3	—	1, 4.1
SPHAERIIDAE	3, 2.4	3, 5.8	4, 1.9
PLATYHELMINTHES: TURBELLARIA			
'MICROTURBELLARIA'	—	—	1, 4
TOTALS	134, 74.6 mg	192, 156.2 mg	156, 132.0 mg

#1 $\bar{x}$ = / Stand. deviat. =

wt. $\bar{x}$ = Stand. deviat. =

Re: Hattie Cove, 0.5 m² sweeps, 1 mm; [illegible]

REPLICATE →	S3 R1 Submerged	S3 R2	S3 R3
DATE →	89.09.09	89.08.09	89.08.09
TAXA			
ANNELIDA: HIRUDINEA:			
GLOSSIPHONIIDAE	—	—	1, 0.6
ANNELIDA: OLIGOCHAETA			
NAIDIDAE	7, <1	3, <1	13, 2.4
ACARINA	1, <1	8, 4.1	17, 48.7[1]
CRUSTACEA			
AMPHIPODA			
Gammarus fasciatus	9, 42.1	7, 4.7	19, 17.9
Hyalella azteca	2, 1.1	—	3, 4.3
CLADOCERA	—	22, 8.5	72, 18.5
CYCLOPOIDA	—	—	10, <1
ISOPODA: ASELLIDAE: Lirceus lineata	6, 8.6	5, 6.2	3, 3.4
INSECTA			
COLEOPTERA			
DYTISCIDAE	2, 1.4	9, 70.0	13, 33.6
GYRINIDAE	3, 16.6	—	2, 6.0
DIPTERA			
CHIRONOMIDAE (TOTAL)	7, 3.6	3, <1	6, 4.3
CHIRONOMINI	6, 3.6	1, <1	4, 4.3
ORTHOCLADIINAE	—	1, <1	2, <1
TANYPODINAE	1, <1	1, <1	—
EPHEMEROPTERA: CAENIDAE	1, 3.5	—	—
HEMIPTERA: CORIXIDAE	—	10, 52.5	11, 85.7
ODONATA: COENAGRIONIDAE	—	1, <1	—
TRICHOPTERA: PHRYGANEIDAE	—	1, <1	—
MOLLUSCA			
HYDROBIIDAE: Amnicola limosa	16, 72.2	6, 40.2	33, 185.5
PHYSIDAE: Physella gyrina	—	—	1, 1.0
PLANORBIDAE (immatures)	1, 0.8	—	—
SPHAERIIDAE	—	2, <1	—
TOTALS	54, 149.9	77, 177.4	208, 363.2

Total #'s $\bar{x}$ = 113, Stand dev. =

Total Wt $\bar{x}$ = 230.2, Stand dev. =

1 - S3R3 ACARINA MADE UP OF 12 - Unionicola, 2.4 mg, and 5 - Hydrachna 46.3 mg

Re: Hattie Cove, 0.5 m² sweeps, 1989, identifications and weights

REPLICATE →	S4R1	S4R2	S4R3
DATE →	89-09-07	89-08-09	89-08-09
TAXA			
ANNELIDA: HIRUDINEA			
GLOSSIPHONIIDAE	–	–	1, <1
ANNELIDA: OLIGOCHAETA (TOTAL)	9, 1.1	–	3, <1
NAIDIDAE	5	–	–
TUBIFICIDAE	4	–	3
ACARINA	3, <1	–	5, <1
CRUSTACEA:			
AMPHIPODA			
Gammarus fasciatus	1, 1.4	2, 1.9	16, 54.9
Hyalella azteca	169, 115.8	104, 147.9	170, 125.4
CLADOCERA: SIDIDAE	20, 3.8	–	42, 12.2
CYCLOPOIDA	2, <1	–	–
ISOPODA: ASELLIDAE: Lirceus	11, 41.5	16, 58.0	6, 31.5
COLEOPTERA: CHRYSOMELIDAE	–	–	6, 47.5
DIPTERA			
CERATOPOGONIDAE	1, <1	2, 1.4	–
CHIRONOMIDAE (TOTAL)	42, 16.6	11, 15.9	10, 2.6
CHIRONOMINI	14, 5.4	7, 3.9	5, 1.1
TANYTARSINI	5, <1	–	1, <1
ORTHOCLADIINAE	3, <1	–	1, <1
TANYPODINAE	20, 11.2	4, 12.0	3, 1.5
TABANIDAE:	–	1, 10.6	–
EPHEMEROPTERA			
BAETIDAE	1, <1	–	3, 2.5
CAENIDAE	4, 6.6	1, 2.7	7, 14.4
EPHEMERIDAE	1, <1	2, 6.0	1, <1
HEMIPTERA			
CORIXIDAE	1, 6.9	1, 0.7	4, 3.0
NOTONECTIDAE	–	–	1, 48.0
LEPIDOPTERA: PYRALIDAE	–	–	3, 3.3
ODONATA			
COENAGRIONIDAE	1, <1	–	5, 1.0
CORDULIIDAE (? EARLY INSTAR)	1, <1	–	–
TRICHOPTERA			
LEPTOCERIDAE	1, 4	2, <1	–
PHRYGANEIDAE	–	2, 3.4	3, 10.4
POLYCENTROPODIDAE	1, <1	–	–
MOLLUSCA			
HYDROBIIDAE: Amnicola limosa	3, 36.9	4, 58.5	6, 78.8
LYMNAEIDAE: Lymnaea stagnalis	–	–	3, 1348.6
PLANORBIDAE: Helisoma anceps	–	–	3, 93.0
VALVATIDAE: V. sincera + tricarinata	4, 25.7	2, 19.8	–
SPHAERIIDAE	3, <1	–	–
TOTALS	279, 256.3	150, 326.8	308, 1877.1

Totals $\bar{x}$ = 245.7, stand. dev.

total wt $\bar{x}$ = 520.1, stand. dev.

Re: Hattie Cove, 0.5 m² sweeps, 1989, identification and weights

REPLICATE →	SSR1 Rock	SSR2 Rock	SSR3 Rock
DATE →	89-08-09	89-08-09	89-08-09
TAXA			
ANNELIDA: OLIGOCHAETA: NAIDIDAE	2, <1	3, <1	14, 1.2
ACARINA	1, <1	—	—
CRUSTACEA:			
AMPHIPODA			
Gammarus fasciatus	1, 3.1	—	4, 2.7
Hyalella azteca	2, 1.6	6, 6.9	6, 1.8
CLADOCERA	3, <1	6, <1	14, 1.4
CYCLOPOIDA	4, <1	—	10, 0.7
ISOPODA: Asellidae: Lirceus + Caecidotea	1, <1	2, 2.2	10, 10.6
INSECTA:			
COLEOPTERA:			
DYTISCIDAE	—	—	3, 2.0
GYRINIDAE	1, <1	—	—
DIPTERA:			
CHIRONOMIDAE (TOTAL)	5, <1	3, <1	35, 12.8
CHIRONOMINI	—	1, <1	28, 9.0
TANYTARSINI	4, 4	1, <1	3, <1
ORTHOCLADIINAE	1, <1	—	2, <1
TANYPODINAE	—	—	2, 3.8
EPHEMEROPTERA			
CAENIDAE	1, 1.3	1, 1.5	—
HEPTAGENIIDAE	—	—	2, <1
LEPTOPHLEBIIDAE	1, <1	—	—
HEMIPTERA: CORIXIDAE	5, 6.5	2, 3.9	4, 3.5
TRICHOPTERA:			
LEPIDOSTOMATIDAE	—	—	1, <1
LEPTOCERIDAE	2, 1.8	—	6, <1
POLYCENTROPODIDAE	1, 2.1	—	—
BRYOZOA: PLUMATELLIDAE*	—	—	1* (NO WEIGHT)
COELENTERATA: HYDRIDAE	—	1, <1	—
MOLLUSCA			
HYDROBIIDAE: Amnicola limosa	—	—	1, 2.6
PLATYHELMINTHES: PLANARIIDAE	1, 1.7	—	4, 3.8
TOTALS	31, 18.1	23, 14.5	115, 43.1

Total #'s $\bar{x}$ = 56.3, SD

Total wt $\bar{x}$ = 25.2, SD

* Bryozoan colony on a bark chip was not counted in the total for the sample, nor weighed.

Appendix III: Taxonomic References used for the Identification of Hattie Cove, 1989, Benthos Samples.

Taxonomic References used to Identify Hattie Cove, 1989, Benthos

General

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13) Cook, D. R. (1974) - Water mite genera and subgenera. Mem. Am. Ent. Inst. No. 21, 860 pg.

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Insecta:

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16) Hungerford, H. B. (1948) - The corixidae of the western hemisphere. U. Kansas Sci. Bull. 32:1-827.

17) Jackson, G. A. (1977) - Nearctic and palaearctic Paracladopelma Harnisch and Saetheria n.gen. (Diptera:Chironomidae). J. Fish. Res. Bd. Can. 34:1321-1359.

18) Oliver, D. R., and M. E. Roussel (1983) - The insects and Arachnids of Canada. Part 11. The genera of larval midges of Canada (Diptera:Chironomidae). Agriculture Canada, 263 pg.

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20) Weiderholm, T. (ed) (1983) - Chironomidae of the Holarctic region. Keys and diagnosis. Part 1 - Larvae. Ent. Scand. Suppl. No. 19, 457 pg.

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APPENDIX B

Field Tally Sheets

AQUATIC RESOURCES MONITORING

WEATHER ---------- DATE ----------

NAMES ---------- TIME----------

STATION # ------- AIR TEMPERATURE --------

DISOLVED OXYGEN mg/l	TEMP. C	DISOLVED OXYGEN mg/l	TEMP.C
1 m. ----------	-----	9 m. ----------	----
2 m. ----------	-----	10 m. ----------	----
3 m. ----------	-----	11 m. ----------	----
4 m. ----------	-----	12 m. ----------	----
5 m. ----------	-----	13 m. ----------	----
6 m. ----------	-----	14 m. ----------	----
7 m. ----------	-----	15 m. ----------	----
8 m. ----------	-----	16 m. ----------	----

SURFACE SEDIMENT (at all inlets) # -------

BELOW SEDIMENT/WATER INTERFACE # -------

PH SURFACE ------- ALKALINITY SURFACE -------

--m.MIDDLE ------- --m.MIDDLE -------

--m.BOTTOM ------- --m.BOTTOM -------

SPECIFIC CONDUCTANCE SURFACE SAMPLE #----- RESULT------

--m.MIDDLE SAMPLE #----- RESULT------

--m.BOTTOM SAMPLE #----- RESULT------

COLOR: clear yellowish brown brown green

TURBIDITY(mean): ----- m.

CREEL CENSUS FOR HATTIE COVE

****

STRATIFIED DATE:

	SUN	MON	TUES	WED	THUR	FRI	SAT
0700-1200 hrs							
1200-1700 hrs							

****

RANDOM DATE ---------- TIME----------

****

PARK WARDEN ----------

WEATHER ----------

RESIDENT --- NON-RESIDENT (CAN) --- NON-RESIDENT (OTHER)--- RSTG ---

OF PERSONS FISHING IN PARTY ------ TIME SPENT FISHING ----

OF FISHING LINES ----- BAIT USED ----------

INDICATE LOCATION ON MAP (SEE OTHER SIDE).

SPECIES	CENTIMETERS TL	FL	SL	GRAMS WT	SCALE SAMPLE(x)	TISSUE SAMPLE(x)	TAG # (IF ANY)

OF FISHING LINES ----- BAIT USED ----------

INDICATE LOCATION ON MAP (SEE OTHER SIDE).

SPECIES	CENTIMETERS TL	FL	SL	GRAMS WT	SCALE SAMPLE(x)	TISSUE SAMPLE(x)	TAG # (IF ANY)

SPECIES AND NUMBER OF FISH RELEASED:

ADDITIONAL COMMENTS:

HATTIE COVE STUDY AREA

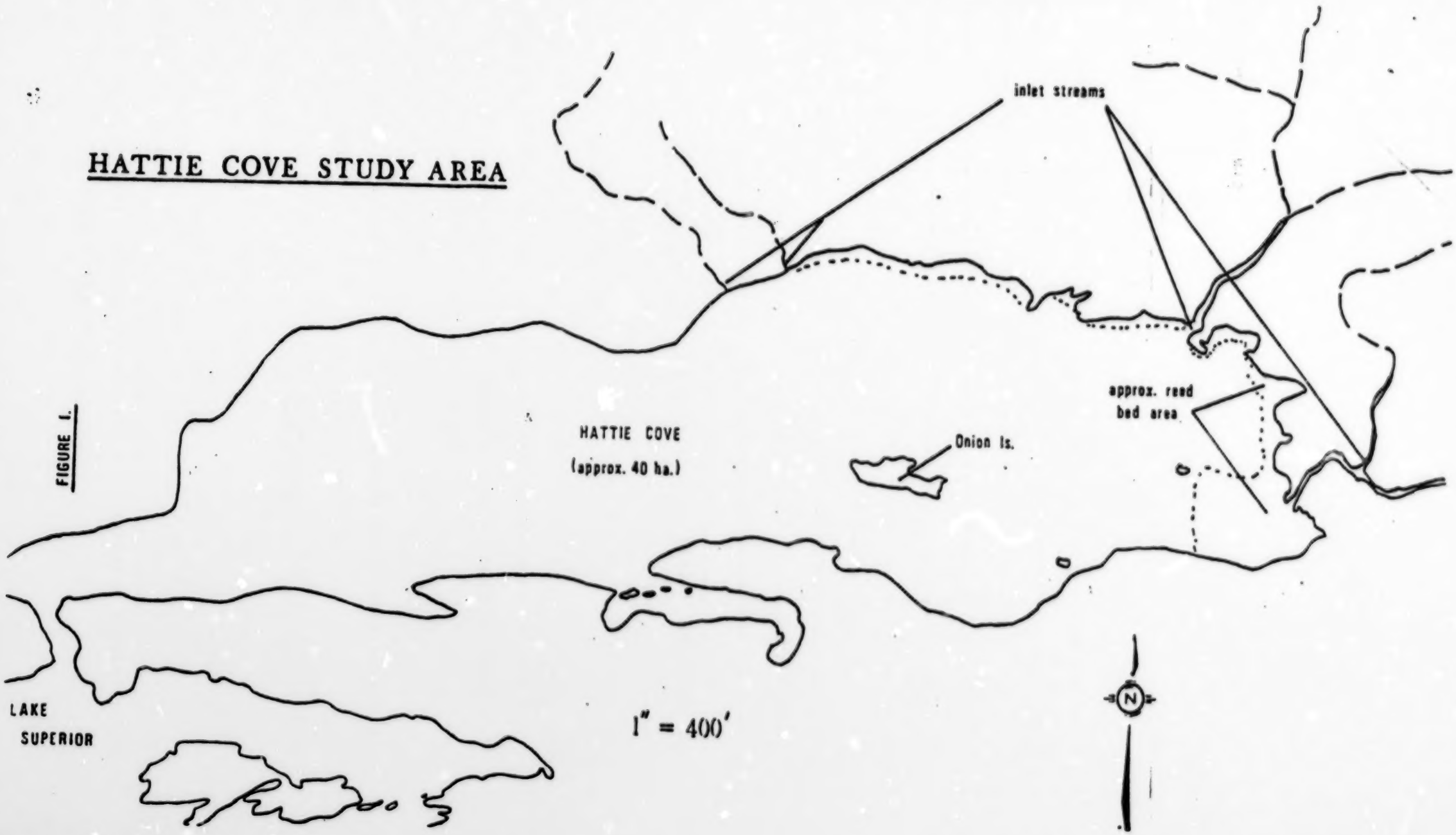


FIGURE 1.

APPENDIX C

Creel Census Arithmetic Formulae

Reports

Ice Fishing Creel:

January 14 - April 23, 1989

November 19 - January 13, 1989

Rod and Reel Creel:

June 24 - November 18, 1989

From both stratified and non-stratified creel forms.

1) catch/unit of effort/person
   (hp) # of pike for each creel

   ($\bar{x}$ hp) mean # of pike (average) for season

   (h_t) total fish for each creel

   ($\bar{x}$ h_t) mean total fish (average) for season

2) fishing pressure: # of hours fished in season (b_t)

3) total # of pike caught (c_t)

4) total # of fish caught (d_t)

5) total # of persons fishing/season (a_t)

6) total # of fishing trips (group) (e)

Example - One Season

Creel 1 a) 2 anglers b) 3 hours c) 1 pike d) 3 fish total
Creel 2 a) 1 person b) 1 hour c) 2 pike d) 8 fish total
Creel 3 a) 4 persons b) 2 hours c) 0 pike d) 1 fish total

e) 3 trips a_T) 7 persons b_T) 6 hours total c_T) 3 pike total d_T) 12 fish total

g) $= \frac{f}{e} = \frac{a_T}{e} = \frac{7}{3} = 2.33$ average # of persons/group

$$h_p = \frac{c}{a.b}$$

$$h_{p1} = \frac{1}{2.3} = .16$$

$$h_{p2} = \frac{2}{1.1} = 2$$

$$h_p3 = \frac{0}{(4)(2)} = 0$$

$\bar{x}$ of $h_p = \frac{2.16}{3} = .72$

$$h_T = \frac{d}{a.b}$$

$$h_{T1} = \frac{3}{2.3} = .5$$

$$h_{T2} = \frac{8}{1.1} = 8$$

$$h_{T3} = \frac{1}{4.2} = .125$$

$\bar{x}$ of $h_T = \frac{8.625}{3} = 2.875$

a.b = Fishing hours/days
a = # of persons/group per creel form
b = # of hours/group per creel form
c = # of pike/group per creel form
d = total fish/group per creel form

e = total # of fishing trips

a_T = total # of persons

g = mean # of persons/group = $\frac{a_T}{e}$

b_T = total # of hours fished/season

c_T = total # of pike caught/season

d_T = total # of fish caught/season

h = catch/unit of effort/person

h_p = pike/person/hour = $\frac{c}{a.b}$

h_T = total fish/person/hour = $\frac{d}{a.b}$

$$\bar{x} \text{ of } h_p = \frac{(h_{p1} + h_{p2} + h_{p3} + \ldots)}{N}$$

$$\bar{x} \text{ of } h_T = \frac{(h_{T1} + h_{T2} + h_{T3} + \ldots)}{N}$$

APPENDIX D

Volume and Mean Depth Calculations for Hattie Cove

Area in Hectares

Surface Area of Each Contour Interval

shore to 2 m	=	19.59 ha
2 m to 4 m	=	4.68 ha
4 m to 6 m	=	5.57 ha
6 m to 8 m	=	2.80 ha
8 m to 10 m	=	3.97 ha
10 m to 10.7m	=	0.99 ha
Bottom (10.7 m)	=	0.13 ha
Total		37.73 ha (surface of Hattie Cove)

The Surface Area of Each Stratum

$37.73 \text{ ha} = a_1$ (surface area of Hattie Cove)

37.86 - 19.59	=	18.14 ha	$= a_2$
18.14 - 4.68	=	13.46 ha	$= a_3$
13.46 - 5.57	=	7.89 ha	$= a_4$
7.89 - 2.80	=	5.09 ha	$= a_5$
5.07 - 3.97	=	1.12 ha	$= a_6$
1.12 - 0.99	=	0.13 ha	$= a_7$ (bottom area of 10.7 m)

Total volume ($10^4 m^3$) of Hattie Cove $= \frac{h_1}{3} (a_1 + a_2 + \sqrt{(a_1)(a_2)})$

$$+ \frac{h_2}{3} (a_2 + a_3 + \sqrt{(a_2)(a_3)}) + \ldots$$

Volume of stratum 1) $= \frac{h_1}{3} (a_1 + a_2 + \sqrt{(a_1)(a_2)})$

$$= \frac{2m}{3} (37.73 + 18.14 + \sqrt{(37.73)(18.14)})$$

$$= 54.68 \times 10^4 m^3$$

Volume of stratum 2) $= \frac{h_2}{3} (a_2 + a_3 + \sqrt{(a_2)(a_3)})$

$$= \frac{2}{3} (18.14 + 13.46 + \sqrt{(18.14)(13.46)})$$

$$= 31.48 \times 10^4 m^3$$

Volume of stratum 3) $= \frac{h_3}{3} (a_3 + a_4 + \sqrt{(a_3)(a_4)})$

$$= \frac{2}{3} (13.46 + 7.89 + \sqrt{(13.46)(7.89)})$$

$$= 31.10 \times 10^4 m^3$$

Volume of stratum 4) $= \frac{h}{3}_4 \ (a_4 + a_5 + \sqrt{(a_4)(a_5)} \ )$

$= \frac{2}{3} \ (7.89 + 5.09 + \sqrt{(7.89)(5.09)} \ )$

$= 12.88 \times 10^4 m^3$

Volume of stratum 5) $= \frac{h}{3}_5 \ (a_5 + a_6 + \sqrt{(a_5)(a_6)} \ )$

$= \frac{2}{3} \ (5.09 + 1.12 + \sqrt{(5.09)(1.12)})$

$= 5.73 \times 10^4 m^3$

Volume of stratum 6) $= \frac{h}{3}_6 \ (a_6 + a_7 + \sqrt{(a_6)(a_7)})$

$= \frac{0.7}{3} \ (1.12 + 0.13 + \sqrt{(1.12)(0.13)})$

$= 0.38 \times 10^4 m^3$

The total volume of Hattie Cove

stratum 1) $= 54.68 \times 10^4 m^3$
2) $= 31.48 \times 10^4 m^3$
3) $= 21.10 \times 10^4 m^3$
4) $= 12.88 \times 10^4 m^3$
5) $= 5.73 \times 10^4 m^3$
6) $= 0.38 \times 10^4 M^3$

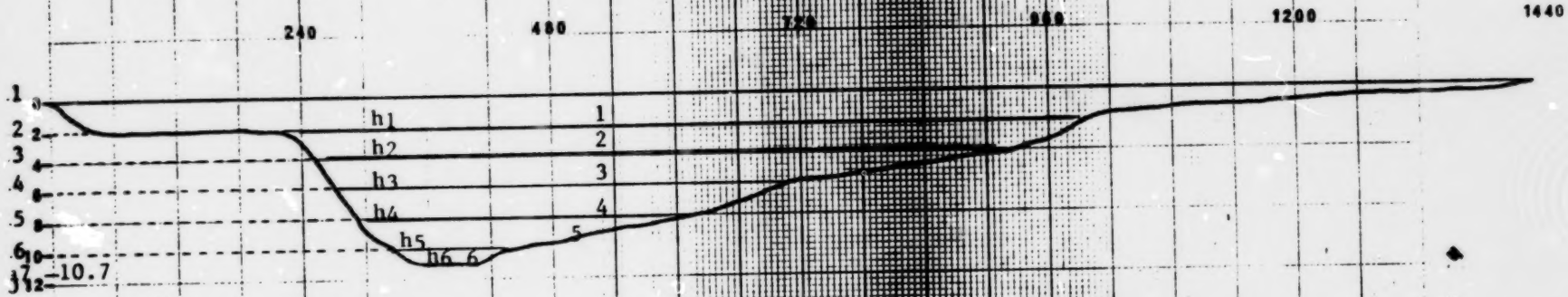
The mean depth ($\bar{x}$) in metre: $\bar{x} = \frac{v \ (10^4 m^3)}{a \ (ha)}$

$\bar{x} = \frac{126.25}{37.73}$

$\bar{x} = 3.35$ metres

Profile of Hattie Cove

Volume and mean depth



Total volume ($10^4 m^3$) of Hattie Cove = $\frac{h_1}{3}(a_1 + a_2 + (a_1)(a_2)) + \frac{h_2}{3}(a_2 + a_3 + (a_2)(a_3) + \ldots$

Mean depth (metres) = $\frac{\text{Total volume } (10^4 \text{ m}^3)}{\text{area (ha)}}$

APPENDIX E
Statistical Formulae for Creel Census

Creel Census (1 year)

Ice Strata = $_i$ = Jan 14 - Apr 23 and Nov 19 - Jan 13
Rod Strata = r = Jun 23 - Nov 18

e = trips (samples or censuses) e_i 298 e_r = 232
a = anglers
b = hours
a x b = anglers - hours = fishing pressure $a_1 \times b_1 = 106.72$
$a_r \times b_r = 60.04$

Did we sample enough to determine fishing pressure accurately?

At what confidence interval did we sample at?

$$\text{Mean} = E(x) = \frac{axb}{e}$$

$$\text{Variance} = S^2 = \frac{1}{m-1}\left[E(x^2) - \frac{(E(x))^2}{m} \right]$$

$$\text{Standard deviation} = S^2$$

$$E(x_i) = \left(\frac{a_i \times b_i}{e_1}\right) = \frac{106.72}{298} = .351$$

$$E(x_r) = \left(\frac{a_r \times b_r}{e_r}\right) = \frac{60.04}{232} = .259$$

ICE

$$S_i^2 = \frac{1}{m_i - 1}\left[E(x^2{}_i) - \left(\frac{E(x_i))}{m_i}\right)^2\right]$$

$$S_i^2 = \frac{1}{298}\left[((6.0)^2+(1.5)^2+\ldots(1.5)^2)-\left(\frac{.351}{298}\right)^2\right]$$

$$= \frac{1}{197}\left[2130.07 - \frac{0.1232}{298}\right]$$

$$= .0034\ [2130.07 - .004]$$

$$= .0034\ [2130.07]$$

$$= 7.242$$

$$S_i = 7.242$$

$$= 2.69$$

if df on T-table

.995 -> .999 fractile

99.5-> 99.9% confidence interval

ROD

$$S_r^2 = \frac{1}{m_r - 1}\left[E(x_r{}^2) - \left(\frac{E(x_r))}{m_r}\right)^2\right]$$

$$S_r^2 = \frac{1}{232-1}\left[((1.0)^2 + (0.0)^2 + \ldots(6.0)^2) - \left(\frac{.259}{232}\right)^2\right]$$

$$= \frac{1}{231}\left[277.58 - \frac{0.0671}{232}\right]$$

$$= .0043\ [277.58 - .0003]$$

$$= .0043\ [277.58]$$

$$= 1.194$$

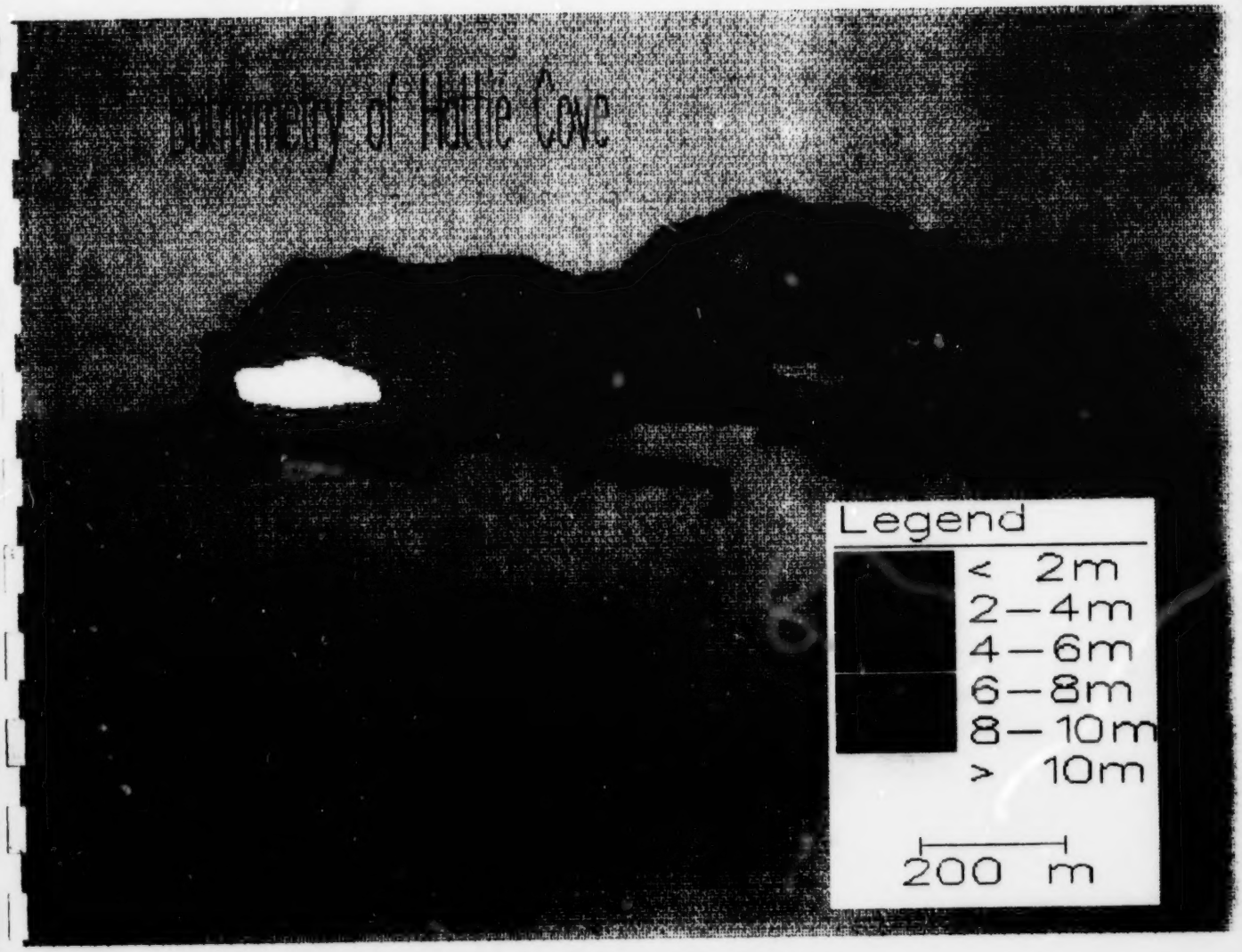
$$S_r = 1.194$$

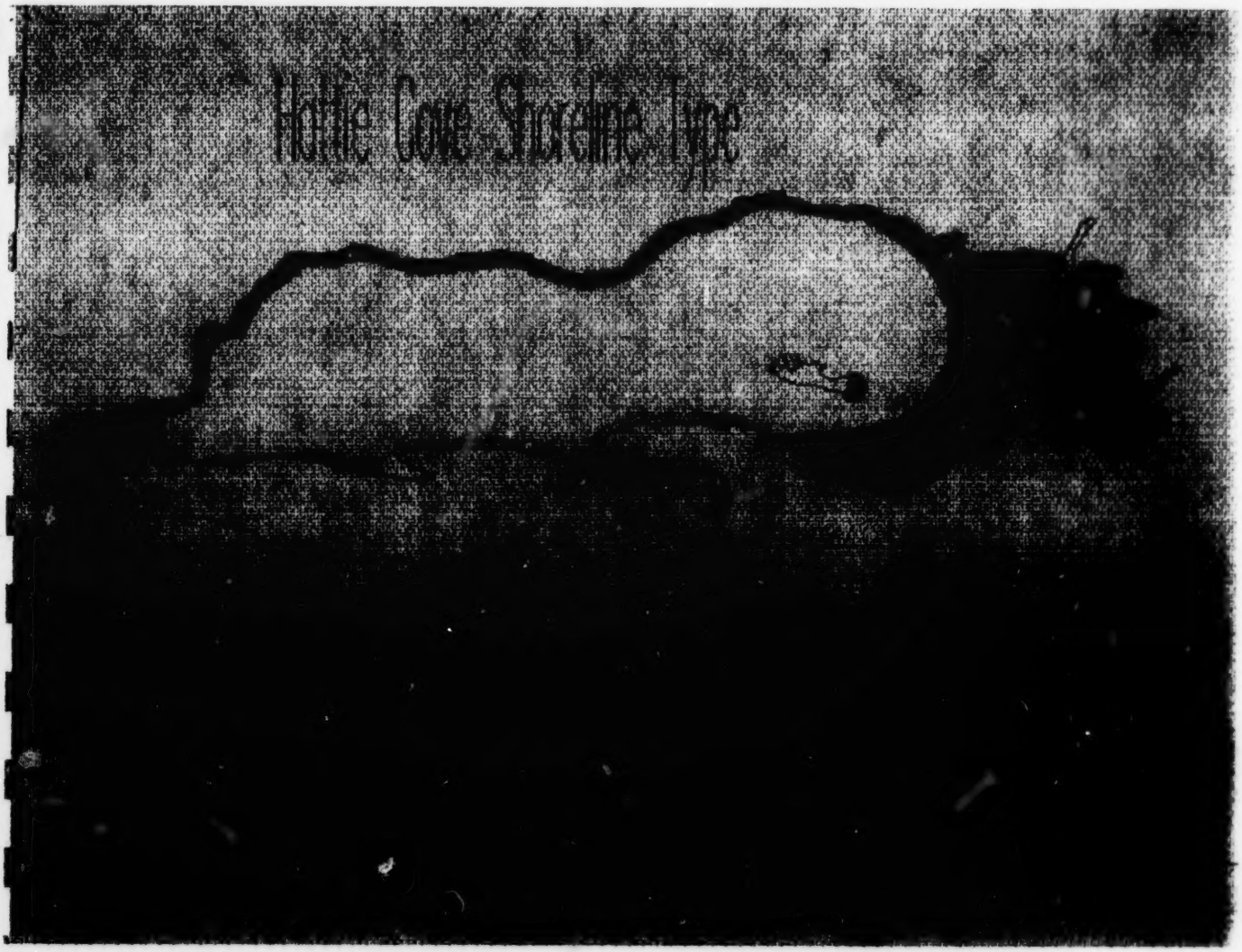
$$= 1.09$$

if df on T-table

.85 ->.999 fractile

85 -> 90% confidence interval


Bathymetry of Hattie Cove
Legend
< 2m
2–4m
4–6m
6–8m
8–10m
> 10m
200 m


Hattie Cove Shoreline Type